HIGH SCHOOL GEOGRAPHY

WHITBECK

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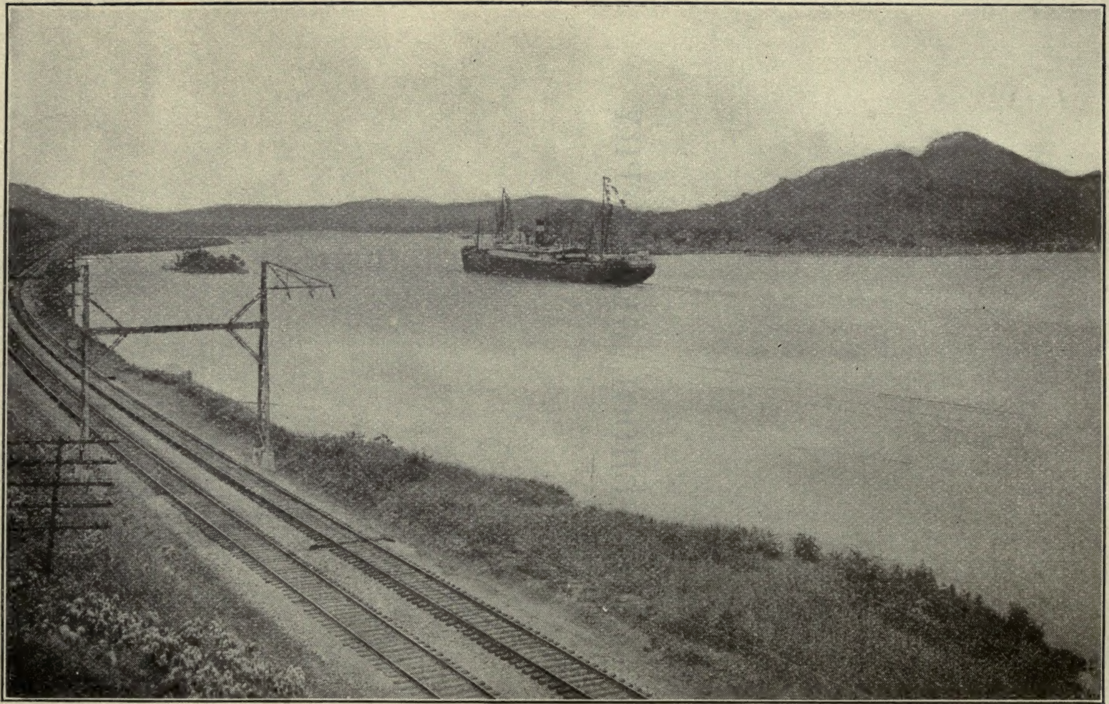

A view of the Panama Canal. The steamship *Ancon* officially opening the canal to traffic, August 15, 1914.

HIGH SCHOOL GEOGRAPHY

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PREFACE

In the discussions of secondary school geography for a decade past, two ideas have constantly been emphasized: (1) that the geography of the secondary school ought to be humanized; and (2) that the influence of geographical environment upon man's mode of life and upon his principal activities should be always in the foreground. With these ideas the author is in sympathy, and he has tried to provide a brief course in geography in essential harmony with them.

Until a few years ago the geography of the secondary school was either physical geography or commercial geography; but thus to separate the two is to rob each of its complement. If the large facts of economic geography are not traced back to the physical *causes* upon which, in a degree at least, they rest, and if the facts of physical geography are not carried forward to some of the great human consequences which arise from them, then each falls short of its possibilities. Geography is not simply a study of the physical environment of man, nor is it simply a study of selected human activities; rather is it a study of both *plus* their interrelation.

Therefore, all of the chapters devoted to the physical aspect of geography include, or are followed by, a discussion of related human aspects. For example, the chapter on Materials of the Earth's Crust is followed by one on the Mineral Resources and Industries of the United States. The chapter on Weathering includes a discussion of soil, and is followed by another on the Agricultural Industries of the United States. The chapter on the physical features of rivers is followed by one on the historical and economic aspects of American rivers, and that by another dealing with six great rivers in other lands and their part in the life of the countries to which they belong. The section dealing with mountains gives

generous attention to Mountains and Man, and the chapter on climate devotes half of its space to Climate and Man. More space is devoted to coast lines and harbors than to the ocean proper. The three chapters on Transportation, Forest Industries, and Manufactures are very largely applied geography. The amount of space given to Volcanoes, Earthquakes, and Glaciers is less than is usually accorded these topics.

Part II of the book consists of four chapters devoted to Latin America, the British Empire, Continental Europe, and China and Japan. It is not the purpose of these chapters to give a systematic account of the geography of these four regions, but rather to select and emphasize certain factors which are highly significant in giving those parts of the world the distinctive character which they have. South America differs widely from Europe in its human geography and the Far East differs widely from both. The aim of Part II is to direct the pupils' minds to outstanding features in the geography of these regions and to indicate some of the ways in which they have influenced the course of human development there; and secondly to bring into prominence the way in which peoples have reacted to the geographical influences to which they have been subjected.

Another aim has been to provide exercises, problems, and questions which call for comparison, observation, reasoning, judging, and generalizing; in short, exercises which give mental training. Various exercises aim to give the pupils experience in topical recitations, in the use of reference books, and in making excerpts, abstracts, and summaries of portions of the text. In various chapters throughout the book questions of location are inserted. The teacher should require pupils to know the location of the more important places about which they are studying; and wall maps should always be at hand.

The author is indebted to many people and to various departments of the U. S. Government for assistance in obtaining photographs; liberal use has been made of maps from the *Geography of the World's Agriculture*, prepared by Messrs. Finch and Baker and published by the U. S. Department of Agriculture. Valuable

suggestions and criticisms have been received from my colleagues or former colleagues, Professors Lawrence Martin, V. C. Finch, F. E. Williams, and E. F. Bean, Miss Genivera Loft, and Mr. Eric Miller of the U. S. Weather Bureau at Madison.

R. H. Whitbeck

University of Wisconsin, Madison
June 1, 1922

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PART ONE

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CHAPTER I

THE EARTH AND ITS NEIGHBORS

THE EARTH

The Three Parts of the Earth. — The earth is made up of (*a*) the land, (*b*) the air, and (*c*) the water. The *solid* portion is composed chiefly of rock and is therefore known as the *lithosphere,* meaning rock-sphere. The *liquid* portion, chiefly contained in the oceans, is known as the *hydrosphere,* meaning water-sphere. The *gaseous* portion, or *atmosphere,* envelops the other two.

The interior of the earth is composed of material that is heavier than the outer shell of the lithosphere; again, this outer shell is composed of material that is heavier than the water or hydrosphere; and the hydrosphere is heavier than the atmosphere. Thus, it is evident that the materials composing the earth as a whole are increasingly lighter from the interior outward.

THE ATMOSPHERE

The air is a real substance and is as much a part of the earth as is the water or the land. As the earth turns upon its axis, the atmosphere turns with it; and, in the yearly journeys of the earth around the sun, the air, water, and land travel together. By the attraction of gravity, air, water, and all loose objects are bound to the earth in spite of its rapid movements of rotation and revolution.

Essential to Life. — The air not only covers the land and the water, but it also penetrates each of these. There is air in the soil and in the pores of the rocks, and were it not for the air in water, fish could not live there. Indeed, nothing that lives on the earth, either plant or animal, can do without air.

Depth, Weight, Density. — While air enters both the lithosphere and the hydrosphere, by far the greater part of it encircles the rest of the earth like a gaseous mantle. Its actual depth or thickness is not known, but it extends at least 300 or 400 miles above the land.

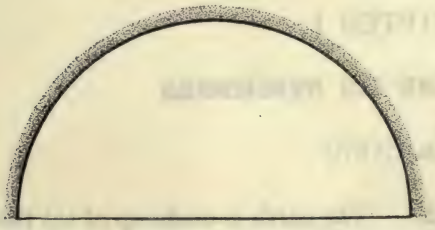


Fig. 1. — In the above diagram, representing one-half of the earth, the black semicircle represents the "crust" of the earth as 50 miles in thickness, while the shaded band represents the proportional depth of the atmosphere if it were 250 miles in thickness.

A thickness of several hundred miles of air seems a great amount; but compared with the earth as a whole it really is not great (Fig. 1). Even if the atmosphere were 500 miles deep, it would then form a layer only about as thick in proportion to the size of the earth as the peel of a lemon is to the size of the lemon.

Although made up of light, invisible gases, the air is a substance and therefore has weight. At sea level the weight is equal to about 15 pounds on every square inch of surface. That part of the atmosphere which is near the bottom supports the weight of all the air above; and, since gases are easily compressed, the gases in these lower layers are pressed more closely together; that is, the air is made more *dense*. But, in going upward in the atmosphere, there is less and less pressure and the air becomes less and less dense. The air particles are farther apart and there is really much less air; such air is said to be *rarefied*. If you ascend 3.6 miles above sea level, one-half of the atmosphere, *by weight*, lies below you and one-half above; but the layer of air above is at least a hundred times as thick as that below, becoming more and more rarefied as the distance from the earth increases. Because there is so little air at

these higher levels, men find it very difficult to climb to the tops of high mountains, and partly for this reason some of the highest mountains have never yet been climbed.

The Hydrosphere

The Ocean Waters. — Water, being a fluid, readily flows into the lower depressions in the earth's surface, the largest of which

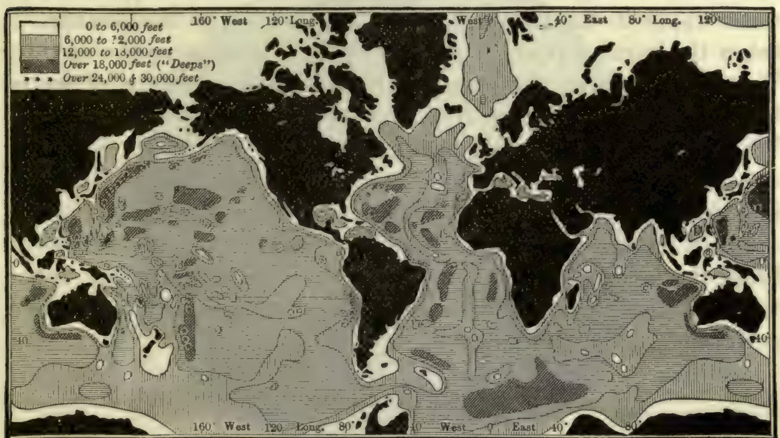


Fig. 2. — Map indicating depths of the ocean. The white borders around the continents are the continental shelves. (*After Murray.*)

are the ocean basins. There is more than enough water on the earth's surface to fill the ocean basins so that the oceans overlap the margins of the continents somewhat (Fig. 2). The Atlantic overlaps the eastern part of North America a hundred miles or more. Although the ocean basins are in some places about six miles in depth, they are shallow in proportion to their width; relatively, the ocean waters form only a mere film on the surface of the earth; the skin of an apple is much thicker in proportion.

The Three States of Water. — Water exists in three states — solid, liquid, and gaseous — and it readily changes from one state

to another. If heated above the boiling point (212° Fahrenheit[1]), it passes into steam, a *gaseous* form of matter. If cooled below the freezing point (32° Fahrenheit), it changes to a *solid* — ice. At temperatures between these two extremes the natural condition of water is *liquid;* and, since the temperatures of the inhabited parts of the earth are usually between 32° and 212° Fahrenheit, water is most commonly seen in the liquid state.

Water Vapor and Rainfall. — While it is true in general that the state of water depends on the temperature, the presence of water vapor in the air at all times, even when the temperature is below the freezing point, is proof that there is an exception to this. Water vapor is at all times escaping from the surface of water bodies, and even from ice, by a process which is called *evaporation.* When this vapor condenses back to the liquid or solid state, it falls as rain or snow. Some of it sinks into the soil and seeps far down into the rocks. Plants could not live if there were not water in the soil, and neither man nor lower animals could live without plants. Since the lands could not be watered by rain if the water vapor were not distributed by the air, we see here a second vital service performed by the atmosphere.

The Lithosphere

The Mantle Rock. — In nearly all places the land surface has a covering of loose earth, varying from a few inches to many feet in thickness, beneath which there is solid rock or *bed rock.* The layer of loose earth, sometimes called *mantle rock,* is almost wholly made of fragments and grains of rock. If this material were evenly distributed over the surface of the land, it would make a layer of no great thickness; probably less than fifty feet on a sphere the size of the earth; this is proportionally no more than a film of dust would be on a schoolroom globe.

The Earth's Interior. — The deepest mines and wells have penetrated only a little more than a mile below the surface,

[1] The Fahrenheit thermometer is the one most commonly used in America. In scientific measurements the Centigrade thermometer is usually employed; it places the freezing point of water at 0° and the boiling point at 100°.

so that it is only the loose mantle rock and the upper layers of the bed rock with which men are acquainted. Therefore, very little is known about the remaining portion of the lithosphere. One fact, however, is important: the farther wells and mines penetrate into the earth, the warmer the rock is found to be. A well in Pennsylvania, 7000 feet deep, showed a temperature of 150° Fahrenheit. While the rate of increase in temperature

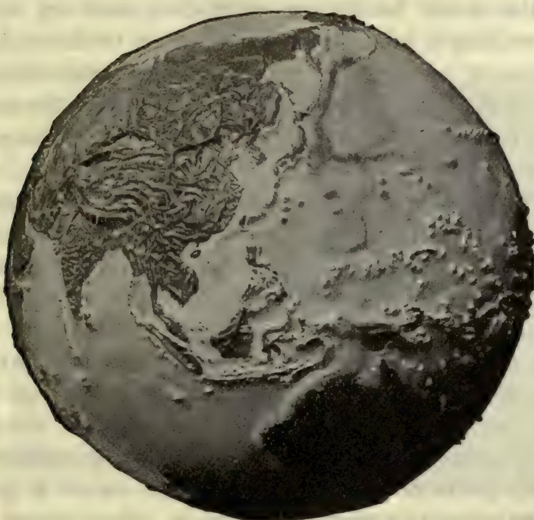


FIG. 3. — View of a portion of a relief model of the earth, showing continents, ocean basins, and islands. The elevations are much exaggerated in height. (*Photographed from Jones' Model of the Earth. Used by permission of Thos. Jones, author, and Rand McNally and Co., publishers. Patent and copyright by Thos. Jones.*)

varies greatly, it averages about one degree for each fifty or sixty feet of descent, after a few yards of the surface layers have been passed through. If this rate of increase in temperature continues to a depth of fifty miles, the rock would be hot enough to melt *if the pressure there were the same as it is at the surface.* At such a great depth, the pressure — produced by the weight of the rock above — is so enormous that, even though very hot, the rock cannot expand sufficiently to melt. It is established

that notwithstanding the great heat in the interior of the earth our planet is as rigid as a solid globe of steel. There are, however, portions of the earth's interior where the rocks are actually melted, as is proved by the lava poured out by volcanoes.

Surface of the Lithosphere. — The surface of the lithosphere seems to us to be very rough. The highest mountains rise between five and six miles above sea level, and the deepest parts of the ocean basins are somewhat over six miles below sea level, making a total difference of about twelve miles. Large as this amount seems, it is very small in comparison with the thickness of the lithosphere as a whole; indeed the earth's surface is no rougher in proportion to the whole sphere than the skin of a smooth orange is to the orange.

Cause of the Larger Surface Features. — The largest of the surface features — the ocean basins and the continents with their mountains and plateaus — have been formed by changes in the level of the earth's crust. As a result, some parts have been raised while others have been lowered. The cause for these changes is not certainly known, but it is evident that the earth has contracted or shrunk to smaller size, as rock, iron, and other substances do when they cool. This has caused a wrinkling of the outer crust as it fits itself to the shrinking interior (Fig. 3). In this way parts of the crust have been raised in great wrinkles to form mountain ranges, while in other places extensive areas of the crust have settled, producing the ocean basins. Still other large areas have either been pushed upward or else did not sink so far as did the ocean basins, and these areas therefore stand up as continents or as large islands.

Thus, the contracting of the earth, whether due to cooling or to some other cause, explains the larger irregularities of the surface; but most of the lesser irregularities have been caused by the action of the weather and by running water. These processes, called *weathering* and *erosion*, will be discussed later.

Gravity. — When Isaac Newton saw an apple fall from a tree, he wondered why it fell *toward* the earth, and he asked himself, "Why did it not fall upward?" As the result of his years

of study, and of the investigations of other men, the working of the *law of gravitation* is now well understood. It is known that every particle of matter exerts an attraction upon every other particle. The earth attracts the moon and the moon the earth; but the earth, being the larger, has the stronger attraction. It is this same attraction of gravitation, exerted by the sun, that keeps the planets revolving around it in their orbits. The attraction of gravitation is not confined to the sun, or to the planets, but *exists in all matter*, whether solid, liquid, or gaseous. Every object about you, even gaseous particles of the air, exerts an attraction upon other objects; but the relatively great size of the earth makes it the chief attraction for all objects on or near it. The earth's attraction upon near-by objects is sometimes distinguished by the term *gravity;* but it is exactly the same force as gravitation.

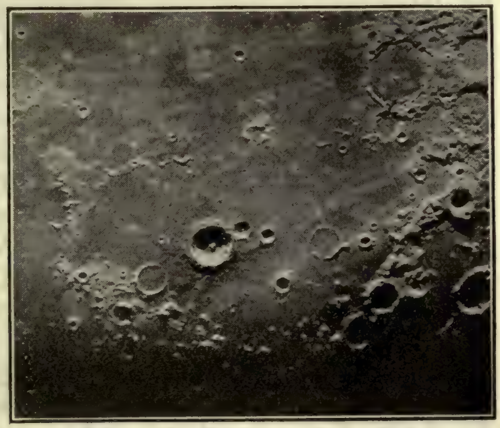


FIG. 4. — A near view of a portion of the moon's surface. The moon is believed to have no atmosphere, water, or life.

Practical Importance of Gravity. — Gravity binds the air, the water, the people, and other objects to the earth and keeps them from flying off into space as the earth spins rapidly on its axis. Because of gravity, objects have weight, water flows downhill, glaciers move down mountain valleys, avalanches plunge down the mountains, soil and rocks creep down hill slopes, rain falls to the earth, dust settles, and many other phenomena occur. Gravity never relaxes its pull. Because of its persistent operation, walls of high buildings must be vertical (plumb), or they topple over. It so pulls upon the

materials in a bridge that great engineering skill is necessary to make a long bridge safe from the danger of falling under its own weight. This force makes it difficult and expensive for locomotives to haul trains up grades; therefore railway builders often follow circuitous routes in order to secure easy grades. The climbing of many flights of stairs tires us because we must use our muscles to overcome the downward pull of gravity. Indeed, in every act of life which requires the moving of objects or of ourselves, we must work against this ceaseless pull of gravity. Yet, if it should stop for one moment, we should be hurled off into space and the earth itself would fly into fragments.

The Earth's Magnetism.—There is another force of attraction in the earth called *magnetism.* If a needle or any small bar of steel is magnetized and then poised so that it may swing freely, it will come to rest pointing in a generally north-south direction, though not usually exactly north and south. Such an instrument is a simple form of *compass.* A magnetic needle balanced at the middle, so that either end may freely rise or fall, is called a dipping needle, or *dip compass.* If a dip compass were carried northward from Detroit, for example, one end of the needle (the positive end) would dip downward more and more until, at a certain point in northern North America, it would stand in a vertical position. This place, called the earth's *north magnetic pole,* is about twenty degrees from the north (geographical) pole. The earth's *south magnetic pole* is almost as far from the south (geographical) pole.

The Earth a Great Magnet. — Thus the earth is a great magnet, and it is the earth's magnetism that makes the compass so useful, especially to mariners and surveyors. The compass needle does not point due north and south in all places, but mariners, and others who make use of it, have charts and tables by means of which they can readily determine the *true* north from the compass readings. The discovery of the earth's magnetism and the compass must be regarded as one of the great steps in human progress. (Why?)

Longitude and Time. — The earth's circumference comprises 360°, and the earth turns upon its axis once in 24 hours. Thus, all places on the earth turn through 360°, or one complete circle, in 24 hours. Dividing 360° by 24 gives 15°; the earth turns through 15° of longitude in one hour of time. If the sun rises at 6 A.M. at New York, it will rise one hour afterward at a place 15° west of New York; two hours afterward at a place 30° west, and so on. If the clocks in each place were set to keep actual time (sun time), we should find a different time in each

FIG. 5. — Map showing the four standard time belts of the United States.

successive place as we travel east or west, and would find it necessary to change our watches constantly; railroads could not have time-tables, and much confusion would result.

Standard Time. — To overcome this difficulty, Standard Time Belts have been adopted. These belts are about 15° wide, and within each belt all places have the same or *standard* time. The clocks in Milwaukee, Indianapolis, Chicago, and St. Louis all being in the central time belt indicate noon at the same time. They keep *standard time.* Clocks in the central time belt (Fig. 5) are one hour earlier than those in the eastern time belt, and one

hour later than those in the mountain time belt, and two hours later than those in the Pacific time belt. The places at which standard time changes in the United States are shown in Fig. 5.

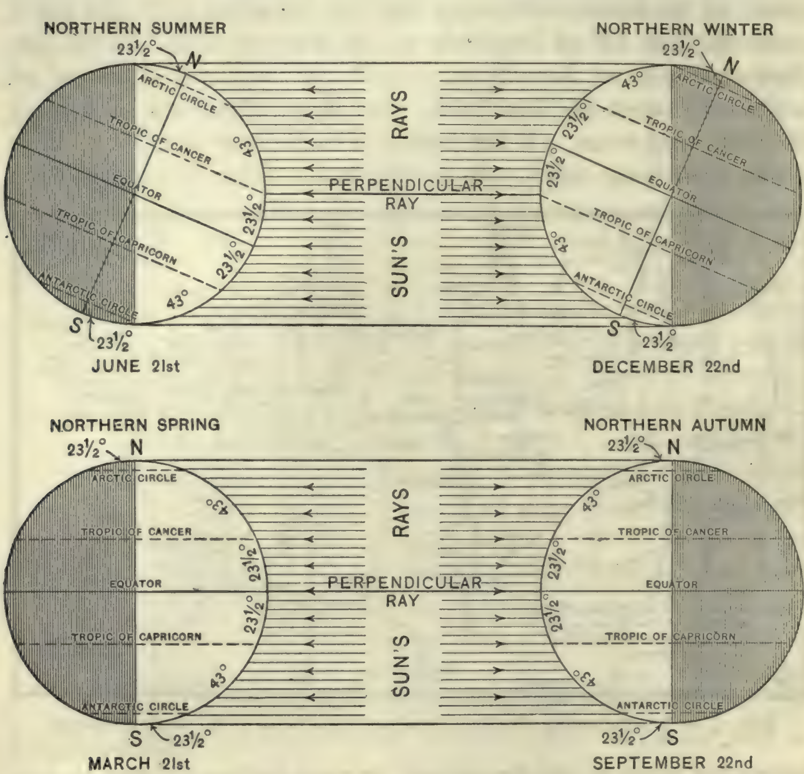


FIG. 6. — The earth in four positions with respect to the sun's rays. The shaded part of each circle represents the night, or dark, hemisphere, and the unshaded part the day, or light, hemisphere. Note where the perpendicular ray strikes the earth in each case; also the extreme northern and extreme southern rays. Locate the five zones — N. Frigid, N. Temperate, Torrid, S. Temperate, and S. Frigid.

Note on Fig. 6. The above drawings are diagrams, not views of the earth. They show diagrammatically where certain rays from the sun strike the earth on the four dates given. It is to be remembered that the axis of the earth is always inclined 23½°. In the lower diagram the axis does not appear to be inclined; it is to be thought of, however, as being so inclined that one pole is tipped directly toward the observer and the other directly away.

Brief Review of the Earth's Motions. — Recall from your earlier study of geography, the following facts:

1. The *axis* of the earth is the imaginary line upon which it rotates.
2. The *north and south poles* are respectively the north and south extremities of this axis.
3. Alternate *day and night* are produced by the *rotation* of the earth on its axis. Explain why. Why does the sun appear to rise and set? Why does it appear to rise in the east?
4. The earth *revolves* about the sun in an elliptical orbit. How long does it take for one revolution? What is an ellipse (Fig. 204)?
5. The earth's axis is inclined $23\frac{1}{2}°$ toward the plane of its orbit. Explain what this means (Fig. 6).
6. The axis is at all times inclined *the same amount and in the same direction*, the north end pointing toward the pole star.
7. Two conditions — revolution in its orbit and continuous inclination of the axis in the *same* direction — give rise to our change of seasons.
8. There are *five zones;* the width of these is determined by the amount of inclination of the earth's axis. Name the zones; tell the width of each in degrees, and show how the inclination of the axis fixes the width of the zones. By what circles is each of the zones bounded (Fig. 6)?
9. *Latitude* is the distance, measured in degrees, north or south of the equator.
10. *Longitude* is the distance, measured in degrees, east or west of the *prime meridian.* Through what place does the meridian run from which most nations reckon longitude?
11. *Meridians* extend from pole to pole and are used to indicate longitude; *parallels* of latitude extend around the earth parallel to the equator, and are used to indicate latitude. Are meridians also parallel? Explain.

EXERCISE I

1. On a globe (or a map) locate the equator; the prime meridian; the north pole; the south pole.
2. What is the latitude of the equator? of the north pole? of the south pole?
3. What circle passes through places that have 0° latitude?
4. What point has neither latitude nor longitude? Is there more than one such point?
5. What is the highest latitude that any place can have? Has any man ever reached this latitude in the northern hemisphere? in the southern?
6. What is the greatest longitude that any place can have?
7. What is meant by east longitude? by west longitude? Name the grand divisions of the eastern hemisphere; of the western hemisphere.
8. How many degrees are there in a large circle? in a small circle?
9. Through what grand divisions does the equator pass? the Arctic circle? the tropic of Cancer? the tropic of Capricorn? Trace the Antarctic circle.

10. Which of the zones includes the most land?

11. Which hemisphere — the northern or the southern — has the greater amount of land?

The Solar System

Members of the Sun's Family. — Large as the earth seems to us, it is only a mere speck in space. Indeed, it is a very small

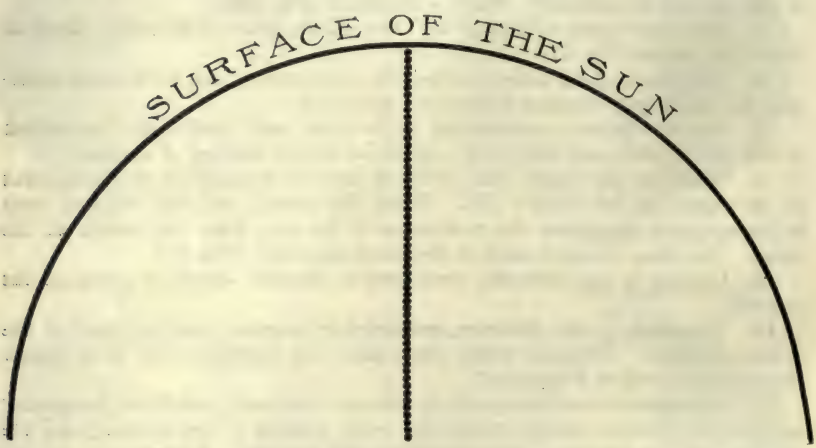


Fig. 7. — The small dots along the radius represent 55 bodies the size of the earth, drawn to the same scale as the circumference of the sun.

part even of the solar system, and the whole solar system is only a very small part of the universe (Figs. 7, 8, 9).

The solar system (Fig. 8) includes: (1) the sun, which is the center of the system; (2) eight *planets* and their *moons* (twenty-five moons are known and others may yet be discovered); (3) some 800 tiny planets, called *asteroids;* (4) a few *comets* (most comets are not a part of the solar system).

Size of the Sun. — The sun is one of the stars, and is of such vast size that if it were a hollow sphere a million earths would be required to fill it. Or, if the earth and moon were within this hollow sphere, with the earth at the center, the moon could revolve in its natural orbit around the earth and have much

room to spare (Fig. 9). So huge is the sun that its mass is 1200 times that of all the rest of the solar system.

The Sun's Heat. — The sun is intensely hot (Fig. 10). In fact, it is far hotter than anything with which we are familiar; heat waves radiate from it in all directions. An exceedingly minute fraction of this heat ($\frac{1}{2\,000\,000\,000}$) comes to the earth; yet a very small part of this minute fraction makes a summer

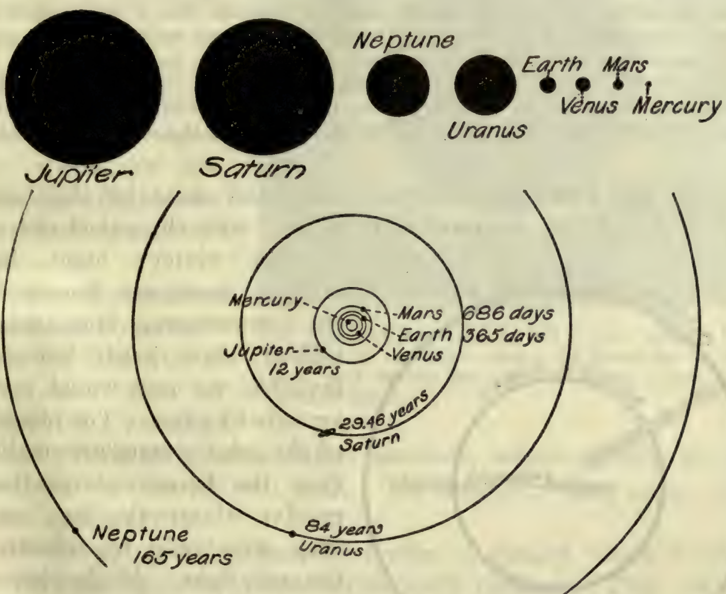


FIG. 8. — The black circles represent the planets of the solar system in proportional sizes. The open circles show the relative sizes of the orbits of the various planets, and the numbers give the lengths of the respective "years" of these planets, or the time it requires each to revolve around the sun.

day seem almost unbearably hot to us. Without the sun's heat, the earth would not be habitable.

The Sun's Distance. — The sun is the center of the solar system around which revolve the planets, held in their *orbits* by its powerful attraction. These orbits are not quite circular, but have a somewhat oval form, called an *ellipse;* the sun is

not at the center but a little to one side (at one of the *foci*) (Fig. 204). For this reason the distance from the earth to the sun is not always the same, but changes throughout the year. The *average* distance of the earth from the sun is about 93,000,000 miles.

Two of the planets, Mercury and Venus, are nearer than the earth to the sun; while Mars, Jupiter, Saturn, Uranus, and Neptune are farther away than the earth. So great is the distance of Neptune, that if at the birth of Christ a messenger had set out to travel from the sun to Neptune and had traveled at the rate of 60 miles an hour, day and night, he would not yet be halfway there. But even this great distance is small compared with the distance that separates us from the stars, the nearest of which (omitting the sun) is 10,000 times as far away as the distance from the sun to Neptune.

Stars and Planets. — Stars are suns and shine by their own light. About five thousand may be seen with the naked eye on a clear winter's night, but millions more are known to the astronomers. How many million stars exist but are invisible, no one would even venture to guess. The planets of the solar system are smaller than the known stars; they revolve about the sun, and they shine only by reflecting the sun's light. All the planets except Mercury and Venus have one or more moons which revolve about them; the earth has only one, while Jupiter has six and Saturn ten. The planets differ greatly in size; Jupiter, the largest, being equal to 1200 earths, while Mercury, the smallest, is much smaller than the earth. Besides being the smallest of the planets, Mercury is the nearest to the sun (Fig. 8).

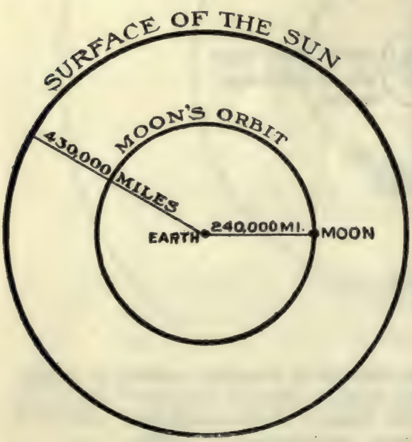


Fig. 9. — The sun is so large that, if it were a hollow sphere with the earth at the center, the moon could revolve in its orbit around the earth entirely within the sun.

The Moon. — Our moon is smaller than any of the eight planets, although it looks to us about as large as the sun. As a matter of fact, the sun is many thousand times larger than the moon, which looks large merely because it is near us (about 240,000 miles away, while the sun is 400 times as distant). This small, cold body, having no air, water, or life, shines, like the planets, by reflecting the sun's light.

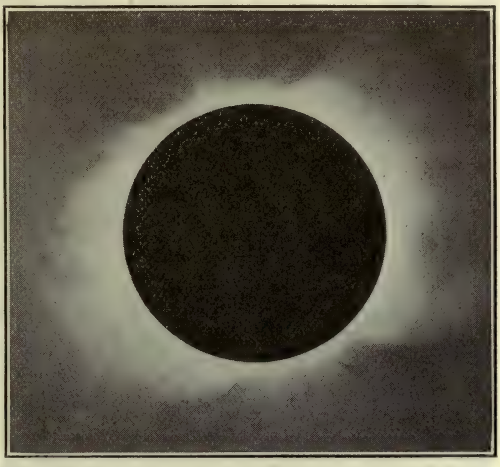


FIG. 10. — View of the sun when at total eclipse; the shadow of the moon covers the entire disk of the sun, and reveals the brilliant corona which surrounds the sun.

Other Members of the Solar System. — Between the orbit of Mars and that of Jupiter is a group of about 800 little planets, called *asteroids*, which revolve about the sun, each in its own path. The largest is only about 500 miles in diameter.

Comets are peculiar, gaseous bodies, a few of which belong to the solar system; others occasionally enter it. They travel in very much flattened orbits; some of them, like Halley's comet, come back at regular intervals, while others are seen once and never return.

Habitability of the Planets. — Men cannot help wondering if there are people on the other planets. It is generally believed that human beings, at all like ourselves, could not live on Mercury or Venus, which are so close to the sun that the temperature must be exceedingly hot. Nor is it thought probable that the more distant planets, such as Saturn, Uranus, and Neptune, could support human life, since they are so far away from

the sun that they receive much less heat from it. Neither does Jupiter seem habitable, for it appears to have an atmosphere densely laden with moisture, and some astronomers believe that it is still so hot that life could not exist upon it. That the moon is not inhabited is certain, since it has neither air nor water.

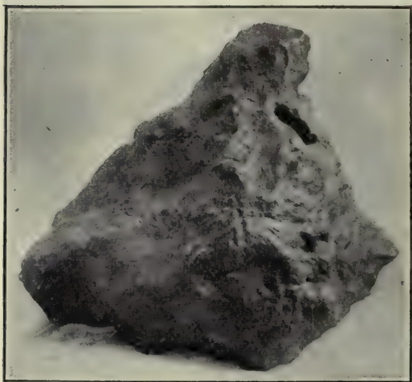


FIG. 11. — A meteorite. These bodies, composed almost wholly of iron, and in some cases weighing many tons, occasionally fall from outer space to the earth.

Of all the planets, Mars is the one that appears to be most like the earth, and astronomers have found evidence which, in the opinion of some, suggests that it is inhabited by intelligent beings; but to this most astronomers have not agreed. It would be interesting to know if there are people on other planets in the solar system, or on planets that may revolve about the far distant stars; but man has not been able to solve this mystery.

SUMMARY

The earth is composed of the land, or lithosphere; the air, or atmosphere; and the water, or hydrosphere. The atmosphere is believed to be a few hundred miles in thickness, but half of it lies between sea level and 3.6 miles above. It has weight and exerts a pressure of about 15 pounds to the square inch at sea level. We live at the bottom of an ocean of air. All forms of life are so made that they cannot exist without air.

The oceans make up most of the hydrosphere; they more than fill the ocean basins and overlap somewhat the margins of the continents. The oceans supply the larger part of the moisture which the winds carry over the land and distribute in the form

of rain and snow. Without this rain the continents would be deserts.

The lithosphere is composed of bed rock and of disintegrated rock, or rock waste; the latter forms a thin and uneven covering over the surface of the land and is often called the mantle rock. The deepest wells and mines are a little more than a mile deep, but they indicate that the temperature increases on an average 1° Fahrenheit for each 50 or 60 feet of descent. The interior of the earth is very hot but not molten. The earth's surface is less rough in proportion to its size than the surface of an orange. The shrinking or contracting of the interior of the earth forces the surface rocks upward in some places and downward in others, thus producing continents, ocean basins, mountains, plateaus, etc.

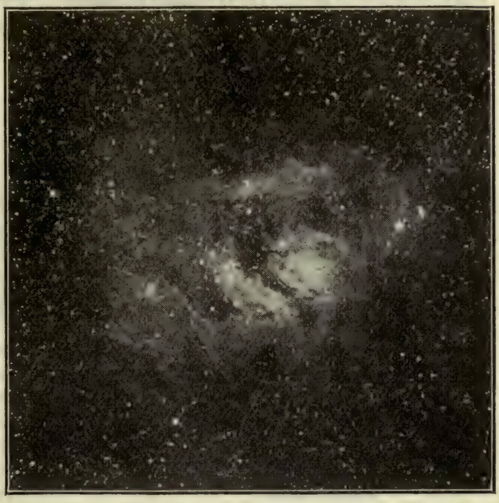


FIG. 12. — Portion of the sky showing hundreds of stars and a nebula of great size.

Every particle or body attracts every other; the earth's attraction is called *gravity*. This attraction binds the air, water, people, and other objects to the lithosphere and gives them weight; it makes movement "downhill" easy and "uphill" difficult. The earth acts like a great magnet with north and south magnetic poles.

The solar system (a very small part of the universe) consists of 1 star (the sun), 8 planets, about 25 moons or satellites, 800 or more tiny planets called asteroids, and a few comets; but

the sun has 1200 times as much matter as all the rest of the solar system. The earth receives only a minute fraction of the total heat emitted from the sun, which is about 93,000,000 miles away. The stars are suns, shining by their own light; planets and moons shine by reflecting light received from the sun. Our moon is only $\frac{1}{400}$ as far from us as is the sun; it is a relatively small body without air, water, or life.

EXERCISE II

1. Make a list of the following terms whose meaning you clearly understand and can explain.
2. Make a second list of the terms whose meaning is not clear to you; from the textbook and dictionary learn the meaning of these terms:

lithosphere	magnetism
hydrosphere	compass
atmosphere	dip-needle
density	vertical
rarefied	north and south poles
fluid	axis
gas	rotation
solid	ellipse
vapor	inclination (of axis)
temperature	latitude
Fahrenheit	parallel of latitude
evaporation	meridian
condensation	prime meridian
bed rock	longitude
mantle rock	equator
surface	sphere
gravity	hemisphere
northern hemisphere	planet
east and west longitude	star
north and south latitude	orbit
Arctic circle	reflected light
Antarctic circle	asteroid
tropic of Cancer	comet
tropic of Capricorn	astronomer
solar system	habitable

EXERCISE III

1. Why do the ocean waters occupy the lowest depressions in the lithosphere?
2. Why is the atmosphere the outermost part of the earth?
3. Why is the atmosphere to be regarded as a part of the earth?

4. Why does the rapid whirling of the earth not hurl loose bodies off into space?

5. Why is the lower air more dense than the upper air?

6. Why do men find it difficult to exert themselves on high mountains?

7. Why is water sometimes a gas, sometimes a liquid, and sometimes a solid?

8. Why does the rock at great depths in the earth not melt, since the temperature is high enough to melt it?

9. Why is the surface of the earth rough?

10. Why are people on the other side of the earth not walking with their heads down?

11. Why is it easier to go downhill than up?

12. Why must the walls of tall buildings be perfectly "plumb"?

13. Why may a compass be used to indicate directions?

14. Why do we have day and night?

15. Why do we have change of seasons?

16. Why does the earth receive only a minute fraction of the heat given out by the sun?

17. Why does the moon shine? the sun?

18. Why does the moon appear to be about as large as the sun when in reality it is much smaller?

CHAPTER II

THE MATERIALS OF THE EARTH'S CRUST

Man's Dependence upon the Materials of the Lithosphere. — Unless our attention is called to the matter, we do not realize how largely we use the mineral substances of the lithosphere. Our food consists chiefly of grains, fruits, and vegetables, which grow from the soil; or of the meat of animals, which feed upon vegetation. Clothing is made of cotton or linen fibers, which come from plants, or of silk or woolen fibers, which come from animals, both of which depend directly or indirectly upon the soil for their life. Houses are built of the wood of trees, which grow in the soil, or of brick, stone, mortar, steel, and other mineral substances. So, all of man's fuels, utensils, tools, machines, and materials of every kind may be traced back to the lithosphere that yields them. During the thousands of years of human history, man has been learning how to utilize for his own well-being and advancement what the earth yields. As he has learned more and more how to use these materials, particularly the metals, he has advanced in civilization.

Variety of Products Obtained from the Lithosphere. — The varied uses to which man puts these materials may be seen in the construction of some great building. The Library of Congress in Washington, D. C., may serve as an example (Fig. 13). The foundation which supports the dome is made of *concrete*, an artificial rock made of crushed *stone*, *sand*, *cement*, and water. The cement is made of finely ground *shale* and *limestone* combined under intense heat. In the walls, *brick* and *tile* made of baked *clay* are used; these are faced on the outside with blocks of white *granite* from New Hampshire, and on the inside with polished *marble*. The framework of the dome is *steel*. Within

the building are marble pillars, arches, and staircases. The roof is made of roofing tile, and the floors of ornamental floor tile. The tiles are made from clay, the *glass* mainly from quartz *sand*, the paint of ground *lead*, *zinc*, or some other mineral, mixed with oil. There are *bronze* doors; *brass* door plates and hand rails, *nickel* fixtures, *gold-leaf* decorations, *copper* wire, *lead* pipe,

FIG. 13. — The Library of Congress, Washington, D. C.

tin gutters, and *asbestos* wrapping for steam pipes. In fact, a fireproof building is built almost wholly of mineral materials.

Rocks, Minerals, and Ores. — Broadly speaking, soil, sand, gravel, and even ice, are forms of rock, but the word is more commonly applied to a mass of hard mineral substance of natural origin. A rock may be composed of only a single mineral, as in the case of pure marble, or it may be made up of a number of minerals, as in granite. Most rocks contain several minerals. *Ores* are minerals or rocks containing enough of some metal to make its extraction profitable. For example, an ounce of gold scattered through a ton of rock would make gold ore, because there would be enough gold to pay for extracting; but even a

hundred pounds of iron to a ton of rock would ordinarily be of little value as an ore, because the iron obtained would not pay for smelting.

Elements and Compounds. — All things on the earth or in

Fig. 14. — Stratified rocks. The different layers show slightly different degrees of resistance. (*U. S. Geol. Sur.*)

it are made up of about 80 *elements* or simple substances. Water, for example, is called a *compound*, because it can be separated into the elements oxygen and hydrogen; but gold, silver, copper, and many other things are regarded as elements, for they have

not as yet been subdivided into anything else. In nature these 80 elements make up every substance and object much as the 26 letters of the alphabet make all the words in our language.

The Rock-forming Elements. — Most of the 80 or more elements which are known to exist in the crust of the earth occur only in small quantities; it is estimated that 8 elements make up 98 per cent of the crust.[1]

Classes of Rocks.[2] — There are hundreds of varieties of rocks but they may all be grouped in three classes:

1. *The sedimentary rocks.* These are by far the most common and are made of sand, clay, pebbles, and other sediments, which were deposited ages ago and afterward pressed and cemented together. Examples — sandstone, limestone, shale. These rocks may be recognized easily, for they practically always exist in *layers* (Fig. 14).

2. *The igneous rocks* are those which have been under such intense heat that they were liquid or molten and afterward cooled. Granite is one of the best known examples. Many varieties of granite may be seen among the tombstones of any cemetery.

3. *Metamorphic rocks* are those which were once either sedimentary or igneous but have since undergone some change which altered their character and appearance. For instance, by prolonged pressure accompanied by heat, limestone has been changed into marble.

The Sedimentary Rocks. — During past ages, under the action of the atmosphere, the rain, and running water, the original surface rocks decayed and much of the rock waste was washed into the streams and carried to the sea. After any severe rain you may notice how muddy the streams look. They are carrying sediment, much of which at last reaches the ocean; this silt or sediment may build up a delta at the river's mouth or it may be drifted back and forth by waves, tides, and currents, until it finally settles to the bottom, usually within 100 or 200 miles of the shore. Some does not reach the sea, but is carried to lakes or is spread over the flood plains of rivers.

Origin of the Sedimentary Rocks. — Such sediments have accumulated little by little to a depth of thousands of feet. The upper layers, resting upon the lower ones, compress them. Underground water brings natural cementing materials and binds the grains together, and in time pressure

[1]

Oxygen, about 47%	Calcium, about 3.4%
Silicon, about 28%	Potassium, about 2.5%
Aluminum, about 7.8%	Sodium, about 2.4%
Iron, about 4.4%	Magnesium, about 2%

[2] During your study of physical geography, you should, if possible, visit places where the earth's bed rock may be seen. This is the only way to get correct ideas about the rocks of the lithosphere. Probably you cannot find in your own locality examples of all of the kinds of rock mentioned in the textbook, but if you can study even one rock-ledge or quarry, it will help, and you will find such a study interesting and enjoyable.

and further cementing convert them into solid *sedimentary rock.* The fine-grained mud when cemented becomes *shale,* and the sand becomes *sandstone.* Farther out at sea, the skeletons and shells of myriads of creatures which live in the sea sink to the bottom, and these make *limestone.* Shells and other fossils are also found in sandstones and shales. The sandstone, limestone, and shale are the commonest rocks found at the surface of the earth. They are in layers, sometimes as thin as paper, but usually several inches

Fig. 15. — Igneous rock of columnar structure, formed by the cooling of a sheet of lava.

or feet in thickness. They are also called *stratified rocks* because they occur in layers or *strata* (Fig. 14).

The Igneous Rocks. — These are less common at the surface of the earth than are the sedimentary rocks. They are usually found in mountainous regions where streams have eroded away the overlying sedimentary rocks and have brought to view the igneous rocks below. They are also common in regions of very ancient, worn-down mountains, like New England, southern Canada, and parts of our eastern and western mountains. When looked at closely, igneous rocks are seen to be made up of crystals of various

minerals, often very small. Granite is a good example, for the crystals of different minerals can be distinguished easily.

The Metamorphic Rocks. — "Metamorphic" means *changed in form.* By heat, pressure, and other agencies acting for a long time, both sedimentary and igneous rocks are greatly modified. Limestone is changed to marble,

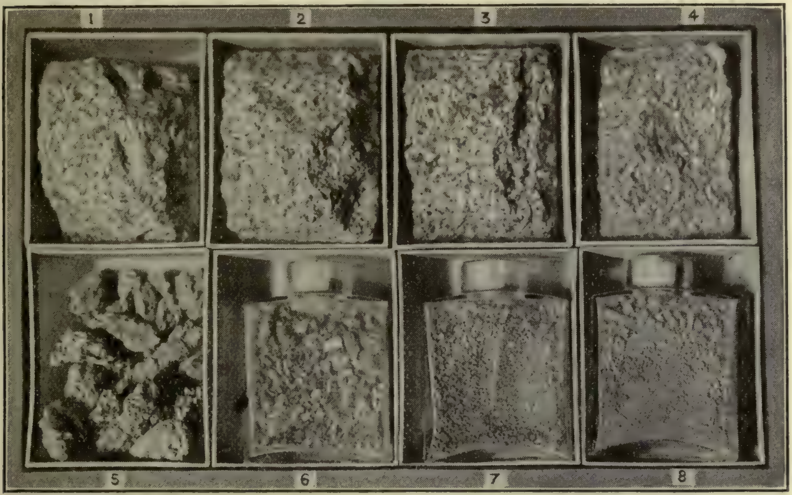


Fig. 16. — Cabinet showing eight stages in the weathering of rock. No. 1 is unweathered rock, Nos. 2 to 8 show progressive stages of weathering into soil.

shale may become slate, and soft coal may be changed to hard coal. Because of the great length of time during which the oldest rocks have been subjected to such changes they are usually the most completely metamorphosed.

Classes of Mineral Substances

The lithosphere contains an almost endless variety of rocks and minerals which man has learned to use. These may be grouped as follows:

The Metals, — iron, gold, copper, and many others — some common, some rare. Make a list of the familiar ones.

The Mineral Fuels, — coal, petroleum, and natural gas.

The Building Stones, — granite, marble, sandstone, limestone, slate, and others.

The Precious and Semiprecious Stones, — diamond, ruby, emerald, sapphire, garnet, agate, amethyst, opal, turquoise, etc.

The Masonry Materials, — (in addition to stone) clay, sand, cement rock, limestone (for lime).

The Mineral Fertilizers, — nitrates (mainly from Chile), phosphate rock, potash salts.

The Mineral Paints, — the body of practically all paints is some form of ground-up mineral, particularly lead and zinc; these are mixed with oil and colors to form paints.

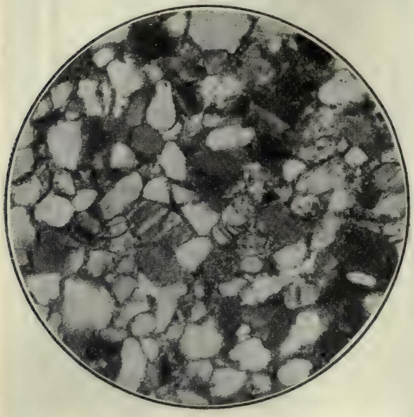


FIG. 17. — Specimen of sandstone, magnified. The fragments are fine grains of sand, cemented together.

Mineral Waters, — containing small amounts of iron, sulphur, and various medicinal salts.

Miscellaneous Minerals, — salt, asbestos, graphite, mica, asphalt, talc, borax, and many more.

From the foregoing list, five of the much-used minerals have been selected for more detailed treatment in Chapter IV:

1. COAL, the greatest of fuels.
2. IRON, the most useful of the metals.
3. GOLD, the precious metal.
4. PETROLEUM, the liquid mineral.
5. SALT, the indispensable mineral food.

EXERCISE IV

1. Explain in your own words the meaning of each of the following terms:

1. lithosphere	5. ore	9. sedimentary rock
2. mineral	6. element	10. metamorphic rock
3. rock	7. compound	11. stratified rock
4. metal	8. igneous rock	12. mineral fuel

2. Let a committee of the class make a list of the *materials from the earth's crust* which are used in the construction of the school building.

3. Of what kinds of building stone are some of the prominent buildings of the village or city constructed?

4. Are there mines, quarries, clay pits, mineral springs, or oil wells in your county or in your part of the state?

5. Let a committee of the class ascertain the mineral resources of the state and report to the class. Reports of the Geological Survey, the annual volumes of the United States Geological Survey entitled *Mineral Resources of the United States*, or the article on your state in a good encyclopedia will furnish the information.

6. The making of an educational collection of materials of the earth's crust is an interesting and instructive exercise. A cabinet (a broad, shallow box with hinged cover) divided into small compartments can be made in the Manual Training Department. This is convenient, but not absolutely necessary. The following plan may be used as a suggestion, but may be modified to meet local conditions.

Suggested Arrangement of a Cabinet and Collection to Illustrate Materials of the Earth's Crust

Quartz	Quartz sand	Sandstone	Quartzite, gneiss, or other metamorphic rock	Glass (manufactured mainly from quartz sand)
Feldspar or other mineral	Clay	Shale	Slate	Ore of iron, copper, or other metal
Calcite or other mineral	Glacial till	Limestone	Marble	Small samples copper, lead, zinc, iron, tin, nickel, and other metals
Salt, mica, asbestos, or other mineral	Yellow, brown, or red soil (stained by iron rust)	Local or other sedimentary rock	Local or other metamorphic rock	Granite or other igneous rock
Peat	Black soil	Soft or bituminous coal	Hard or anthracite coal	Petroleum or asphalt

CHAPTER III

MINERAL RESOURCES AND INDUSTRIES OF THE UNITED STATES

Their Great Importance. — Nature has richly endowed the United States, both in its great extent of agricultural land, and in

FIG. 18. — A cluster of quartz crystals. They are normally hexagonal prisms terminating in hexagonal pyramids.

its great mineral wealth; its known mineral resources are greater than those of any other nation. It is difficult to appreciate

the large part which the minerals play in the daily life of the people of civilized countries. Since 1885 our population has doubled, but the quantity of iron mined in the United States has increased twenty times. No nation to-day can rise to a place of leadership unless it possesses coal and iron. The quick rise of the United States to the position of the greatest of manu-

FIG. 19. — Mining a coal vein of good thickness. The use of machines has greatly increased the output of coal per man. (*U. S. Bur. of Mines.*)

facturing nations could not have occurred without the almost unlimited supply of these two minerals. The United States and the Allies could not have won the great World War without America's enormous resources of coal, iron, petroleum, and copper.

COAL

Origin. — Man could do without gold and silver, but without coal and iron he never would have made a tithe of his present advancement. In past geological ages there were periods when dense vegetation covered great areas of low, wet lands. Here

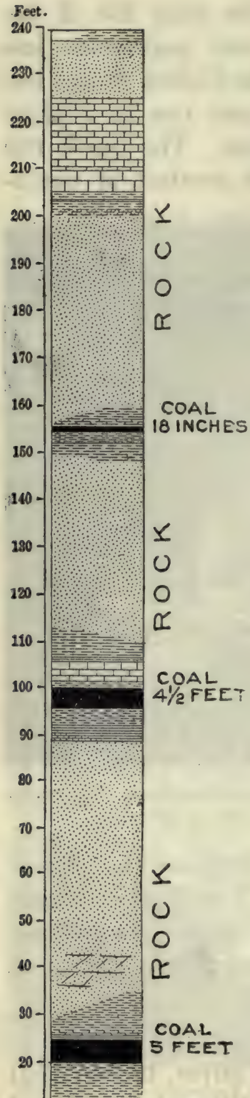


Fig. 20. — A section of the coal measures of western Pennsylvania.

mosses, shrubs, and fernlike trees grew luxuriantly. In time vast quantities of vegetable matter collected in these swamps and from it thick beds of peat formed and covered thousands of square miles. At times the peat beds were totally submerged, and clay or sand was washed in upon them. In this way were built up the rocks known as the coal measures, consisting of layers of coal alternating with layers of rock (Fig. 20).

Where the World's Coal Is Found. — Figure 21 shows what large areas of the United States are underlain with coal; it is estimated that this country has one-half of the coal of the world. About one-sixth of its total area has coal beneath the surface, but 90 per cent of all the coal we use is mined east of the Mississippi. Canada has a sufficient supply, but it is not favorably located, while South America has very little indeed. Europe is well supplied. China has vast fields as yet scarcely touched. Africa has but little and Australia only a moderate amount.

Peat, the beginning of coal, is a spongy, black or brown mass of leaves, roots, stems, etc., which collects in some swamps and is partially protected from decay by the covering of water. In some countries peat is dug out in blocks, dried in the sun, and burned for fuel. In Ireland, for example, it is an important source of fuel.

Lignite is sometimes called brown coal. It is a better fuel than peat and is mined in limited quantities in the West and South.

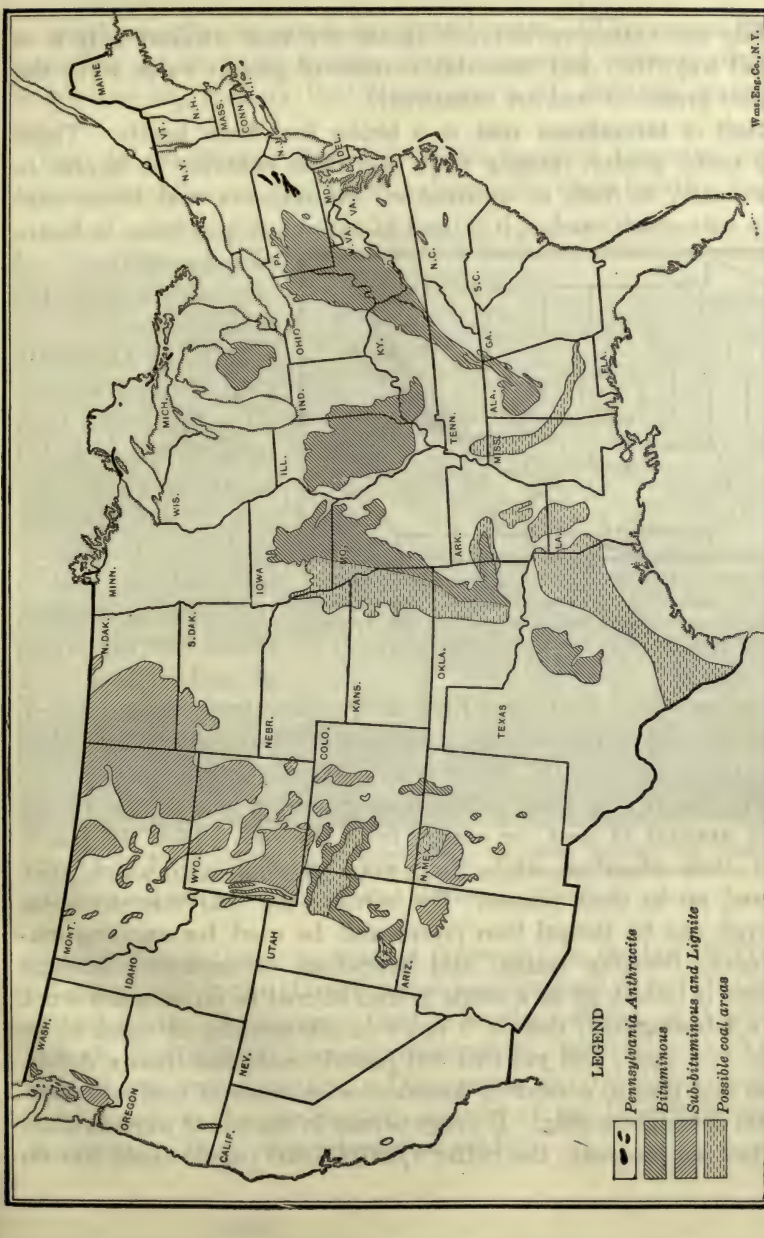


FIG. 21. — Coal areas of the United States. In the portions marked "Possible coal areas," coal is known to exist, and, in places, it is being mined.

While our extensive beds of lignite are now utilized only in a small way, they will some day become of greater value when the higher grades of coal are exhausted.

Soft or bituminous coal is a better fuel than lignite. There are many grades, ranging from one little superior to lignite to one nearly as hard as anthracite. Bituminous coal burns rapidly with much smoke; it is used in enormous quantities in factories, locomotives, and steamships, and in the making of coke.

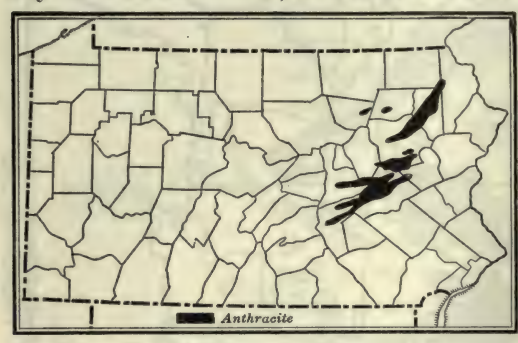


FIG. 22. — The black areas represent the anthracite coal fields of Pennsylvania. From these small areas comes practically all of the anthracite coal mined in the United States.

Hard or Anthracite Coal. — Substantially all of this comes from a small area of 480 square miles in eastern Pennsylvania (Fig. 22). It was once soft coal like that in the middle western states, but the layers of coal and of rock have been bent into great folds as the mountains were uplifted, and the heat and pressure produced by this folding have had a part in changing the bituminous coal into anthracite.

The Energy in Coal. — The importance of coal is due to the vast amount of heat, or energy from the sun, which the plants and trees absorbed while they were growing, and which they stored up in their tissues. By burning the coal this stored-up energy can be turned into power and be used for running machinery, drawing trains, and propelling steamships. Enough power is locked up in a single pound of coal to do as much work as a laboring man does in a day; in 300 pounds, as much as he does in a year; and yet this 300 pounds costs less than a dollar. It is said that in a modern locomotive an ounce of coal will draw a ton of freight a mile. If every person in the world were an able-bodied workingman, the entire 1,600,000,000 people could not do

as much work as is now being done by coal. This means that man has, as it were, another human race of workers placed at his service, workers that require no food, clothing, or shelter.

Coal in the United States. — Eight hundred thousand men are employed in our coal mines; these with their families make

FIG. 23. — Cars of bituminous coal pass from the mine, through the weighing house, up the inclined plane and into the tipple where they dump the coal into railroad cars below. (*U. S. Bur. of Mines.*)

a population as large as that of Norway. In the last 40 years the use of coal in the United States has increased about 20 times as fast as the population. Coal does the cooking or heating, or both, in 10,000,000 homes in this country, besides doing 75 per cent of our manufacturing. One reason why manufacturing is done mainly in the northeastern quarter of the United States is the presence there of our best coal fields.

Distribution in the United States. — It is estimated that we have at least 3,000,000 million (3,000,000,000,000) tons of coal which can be mined; about $\frac{1}{6000}$ of this is now being used yearly, but the mining goes on more and more rapidly. The Appalachian coal field, which yields more than all the others combined, extends from Pennsylvania to Alabama (Fig. 21). It is 900 miles long and from 30 to 180 miles wide. The separate seams or layers of coal vary from less than an inch to many feet in thickness, but, as a rule, only the seams that are four feet or more thick are worked. At present 90 per cent of the coal mined in the United States is mined east of the Mississippi River.

Fig. 25. — Coal from a mine mouth in the hillside is dumped from the mine cars into the chute which delivers it to the railroad cars on the track below. (*U. S. Bur. of Mines.*)

Waste. — Mining methods in the past have wasted practically half of the coal by leaving it in great pillars in the mines to support the rock above. Our engines utilize scarcely 15 per cent of the energy in the coal, and lose the rest. Unless the people of this generation learn to be less wasteful of coal, future generations may suffer; but to a certain extent the steadily rising price of coal will check this waste.


POLITICAL MAP OF THE
UNITED STATES
Scale of statute miles
0 50 100 200 300 400 500
Williams Eng. Co., N.Y.
D O M I N I O N
M E X I C O
PACIFIC OCEAN
GULF OF CALIFORNIA
LOWER CALIFORNIA
Tropic of Cancer
Longitude
WASHINGTON
OREGON
CALIFORNIA
NEVADA
IDAHO
MONTANA
WYOMING
UTAH
ARIZONA
COLORADO
NEW MEXICO
NORTH DAKOTA
SOUTH DAKOTA
NEBRASK
KANSA
OKLA
T E X
Vancouver
Victoria
Bellingham
Everett
Seattle
Olympia
Tacoma
Spokane
Yakima
Walla Walla
Astoria
Portland
Salem
Eugene
Baker
Medford
Boise
Pocatello
Coeur d'Alene
Missoula
Great Falls
Helena
Anaconda
Butte
Billings
Miles City
Sheridan
Cheyenne
Laramie
Ogden
Salt Lake City
Provo
Reno
Carson City
Ely
Tonopah
Goldfield
Sacramento
Berkeley
Oakland
San Francisco
Pasadena
Los Angeles
San Diego
Phoenix
Globe
Miami
Tucson
Bisbee
Douglas
El Paso
Santa Fe
Las Vegas
Albuquerque
Roswell
Raton
Greeley
Boulder
Denver
Grand Junction
Colorado Springs
Pueblo
Minot
Bismarck
Aberdeen
Lead
Pierre
Grand Island
Hutchinson
Wichita
Oklahoma
Wichita Falls
Fort Worth
Austin
San Antonio
Laredo
Olympic Mts.
Mt. Rainier
MT. RAINIER NAT. PARK
Mt. Hood
Columbia R.
Snake R.
Harney L.
CRATER LAKE NAT. PARK
Klamath L.
Mt. Shasta
Lassen Pk.
Humboldt R.
YOSEMITE NAT. PARK
SEQUOIA NAT. PARK
Mt. Whitney
GLACIER NAT. PARK
YELLOWSTONE NAT. PARK
Missouri R.
Yellowstone R.
Fremont Pk.
Big Horn
Black Hills
Cheyenne R.
Great Salt Lake
Sevier L.
WASATCH RANGE
Green R.
Colorado R.
Gila R.
Pikes Peak
Arkansas R.
N. Platte R.
S. Platte R.
Platte
Canadian R.
Red R.
Rio Grande
Pecos R.
L. Manitoba
Devils L.
125° 120° 115° 110° 105° 100°
50° 45° 40° 35° 30° 25°

FIG. 24


95°
90°
85°
80°
75°
70°
65°
50°
C A N A D A
L. Nipigon
L. of the Woods
Rainy L.
Rainy R.
Red L.
LAKE SUPERIOR
St. Marys R.
Sault Ste. Marie
Quebec
St. Lawrence R.
St. John R.
Ottawa R.
Montreal
Ottawa
MAINE
Bangor
Augusta
Lewiston
Portland
MINNESOTA
Hibbing
Duluth
Superior
St. Cloud
Mississippi R.
Minneapolis
St. Paul
Winona
Rochester
MICHIGAN
L. MICHIGAN
Green Bay
LAKE HURON
Georgian Bay
Saginaw Bay
Saginaw
Flint
L. St. Clair
Toronto
Hamilton
L. ONTARIO
Rochester
Syracuse
Utica
Schenectady
Troy
Albany
Watertown
Adirondack Mts.
L. Champlain
Burlington
Montpelier
VT.
White Mts.
N.H.
Concord
Manchester
Boston
C. Cod
Worcester
MASS.
Providence
NEW YORK
Buffalo
Binghamton
Hartford
CONN.
New Haven
WISCONSIN
Oshkosh
La Crosse
Milwaukee
Madison
Racine
Kenosha
Grand Rapids
Lansing
Kalamazoo
Detroit
L. ERIE
Erie
Cleveland
Sioux Falls
Sioux City
Waterloo
Dubuque
IOWA
Des Moines
Cedar Rapids
Davenport
Council Bluffs
Omaha
Rockford
Cicero
Chicago
Gary
South Bend
Toledo
Ft. Wayne
Akron
Youngstown
Canton
Pittsburgh
PENNSYLVANIA
Wilkes-Barre
Scranton
Allentown
Harrisburg
Reading
Newark
Trenton
New York
Jersey City
LONG I.
MARTHAS VINEYARD
Philadelphia
Wilmington
Delaware Bay
40°
Peoria
ILLINOIS
Springfield
Decatur
Terre Haute
Indianapolis
INDIANA
Wabash R.
OHIO
Dayton
Columbus
Cincinnati
Covington
Wheeling
Baltimore
MD.
Annapolis
D.C.
Washington
DEL.
WEST VIRGINIA
Charleston
Huntington
VIRGINIA
Richmond
Newport News
Norfolk
Portsmouth
Chesapeake
Atchison
St. Joseph
Leavenworth
Kansas City
Kansas R.
Topeka
Kansas City
Jefferson City
St. Louis
MISSOURI
E. St. Louis
Evansville
Frankfort
Lexington
Louisville
Ohio R.
KENTUCKY
Roanoke
Winston-Salem
BLUE RIDGE
Roanoke R.
Raleigh
Albemarle Sd.
Pamlico Sd.
C. Hatteras
35°
Cairo
Pittsburg
Joplin
Ozark Plateau
Springfield
Nashville
Knoxville
TENNESSEE
Asheville
Mt. Mitchell
NORTH CAROLINA
Charlotte
Tulsa
Muskogee
Ft. Smith
ARKANSAS
Memphis
Chattanooga
Greenville
SOUTH CAROLINA
Columbia
Wilmington
C. Fear
Arkansas R.
Little Rock
Hot Springs
Pine Bluff
Tennessee R.
Atlanta
Augusta
Savannah R.
Birmingham
GEORGIA
Macon
Charleston
MISSISSIPPI
Mississippi R.
ALABAMA
Montgomery
Vicksburg
Meridian
Jackson
Savannah
Dallas
Shreveport
Red R.
Sabine R.
Alabama R.
Chattahoochee R.
30°
Natchez
Mobile
Tallahassee
Jacksonville
St. Augustine
LOUISIANA
Baton Rouge
Pensacola
FLORIDA
St. Johns R.
Beaumont
Houston
Galveston
New Orleans
C. San Blas
Tampa
Tampa Bay
L. Okeechobee
ATLANTIC OCEAN
The Everglades
Miami
25°
BAHAMA ISLANDS
Nassau
GULF OF MEXICO
C. Sable
Key West
Florida Strait
Tropic of Cancer
Havana
CUBA
95°
from
90°
Greenwich
85°
80°
75

FIG. 24

Iron

Occurrence in Nature. — Fortunately for mankind, iron, the most useful metal, is readily obtained. On an average, iron forms nearly $4\frac{1}{2}$ per cent of the earth's crust. Only three elements, oxygen, silicon, and aluminum, are more common. It occurs in

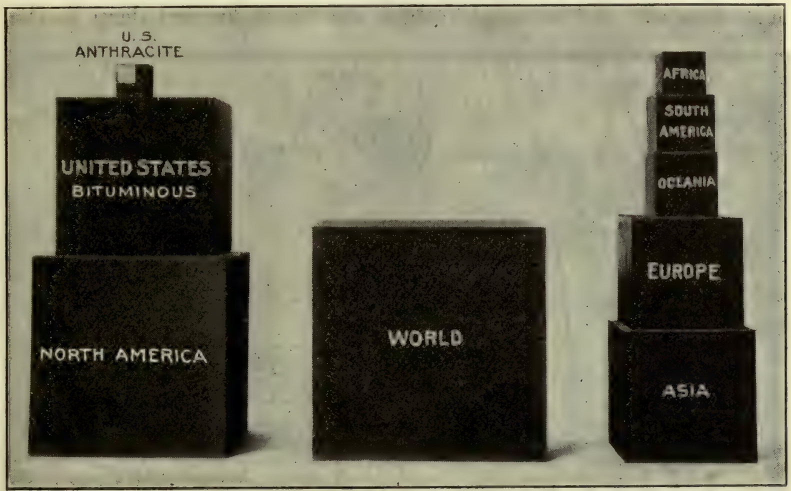


Fig. 26. — The above cubes are proportional in volume to the estimated coal resources of the United States, the world, and the various continents. The vacant space in the anthracite cube represents the proportion already mined.

more than a hundred different minerals, but four of these supply practically all of the iron which is actually used, and one of them (hematite) supplies nine-tenths of the iron smelted in the United States.

A small quantity of iron is present in nearly all rocks and shows in the yellow or brown stain which discolors them when they weather; soils owe their rusty color to the iron in them. The quantity of iron in most rocks is small, and only when some natural agency has brought the iron together or concentrated it is there enough to pay for mining. Just as special circumstances in past ages have led to the accumulation of

salt or coal or petroleum in certain places, so have they at times caused the accumulation of iron. In most cases these iron deposits would not pay for mining if the ore had not been still further concentrated by the prolonged action of underground waters.

How Iron Ore Is Obtained and Handled. — Iron ore is usually mined in one of two ways: either the ore is located deep in the

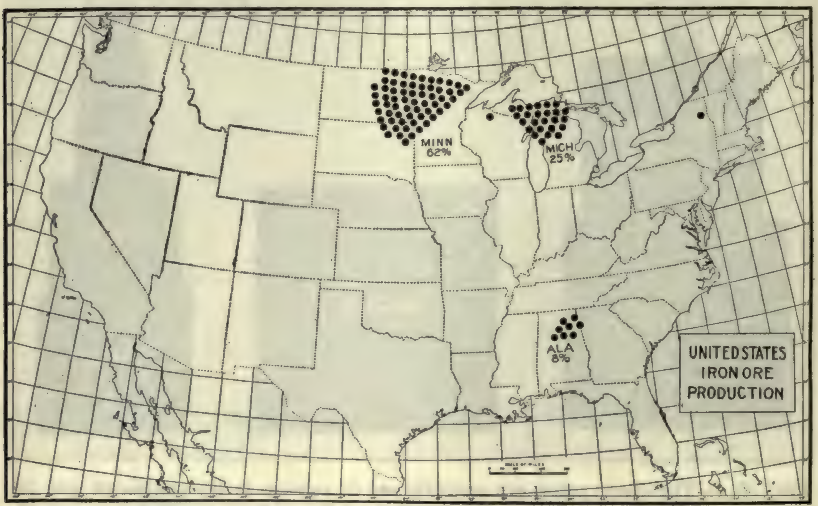


FIG. 27. — Percentage of iron ore mined in different parts of the United States in an average year. Note that three states — Minnesota, Michigan, and Alabama — produce 95 per cent of the total.

Each dot represents one per cent. States producing less than one per cent not shown.

earth and must be obtained by digging down to it, or else it lies near the surface and may be mined by "open-pit" methods. The most productive mines in the world are the open-pit mines of the Mesabi Range in northeastern Minnesota. Here ore of great richness lies almost at the surface. By removing a top layer of glacial drift the ore is reached and can be shoveled up like gravel in steam shovels which scoop up several tons at a time and load a 50-ton car in three or four minutes (Fig. 29). The ore trains then proceed to Superior, Duluth, or Two Harbors on Lake Superior and run out on high trestles, called ore docks,

reaching nearly a half mile out into the lake (Fig. 30). Built into the ore docks under the railroad tracks are storage bins high above the water. Spouts lead from the bins to the ore steamers, which carry the ore down the lakes, chiefly to ports on Lake Erie and Lake Michigan. The ore cars have trap doors in the bottom; when these are opened, the 50 tons of ore slides into one of the bins below. When the steamers

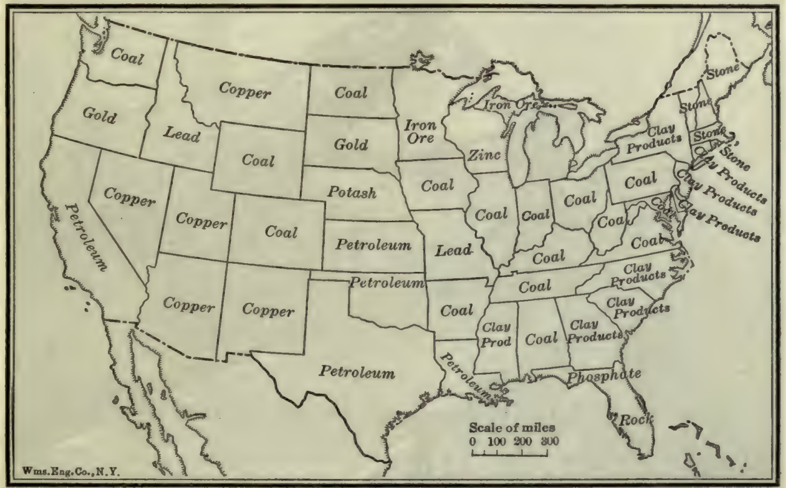


FIG. 28. — Map showing the mineral product of largest annual value (1920) in each state.

carrying as high as 14,000 tons of ore reach their destination, they are quickly unloaded by powerful machinery. So cheaply is the ore mined, handled, and transported that, despite the high wages paid in this country, steel can be made in the United States at lower cost than anywhere else in the world. The fleet of ore-carrying steamers on the Great Lakes is greater than the entire merchant fleet of some important nations, and the tonnage of ore passing through the Detroit River in the seven or eight open months is several times as large as the total tonnage passing through the Suez Canal in a year.

Iron and Steel Centers. — Extracting the metallic iron from

the ore which contains it requires intense heat. This is obtained by burning coke mixed with the ore and with limestone in the smelting furnaces. The heat causes the limestone to unite with the earthy material in the ore; the iron is set free and flows to the bottom of the furnace, whence it is drawn out, a white-hot liquid, and is cast into pig iron or is made into steel. The

Fig. 29. — Iron ore loaded by steam shovel in an open-pit mine in northern Minnesota. (*Courtesy Oliver Iron Mining Co.*)

smelting of ore and the manufacture of steel require an enormous amount of coke and coal. Hundreds of millions of dollars of capital are invested and tens of thousands of men are employed. The largest corporation ever organized, having a capital of more than a billion dollars, is engaged in the production of iron and steel. Since coke is essential and is produced mainly from eastern coal, and since the demand for steel is greatest in the East, the iron and steel industry became established in

the East, especially in the Pittsburgh district and near the Great Lakes in New York, Ohio, Indiana, and Illinois. So intimately is this giant industry interwoven with all other industries that men gauge the prosperity of the country from month to month by watching the activity in the iron and steel trade.

The Principal Iron-mining States and Countries. — Eighty per cent of our iron ore comes from the region of Lake Superior. The most important group of mines is in the famous Mesabi

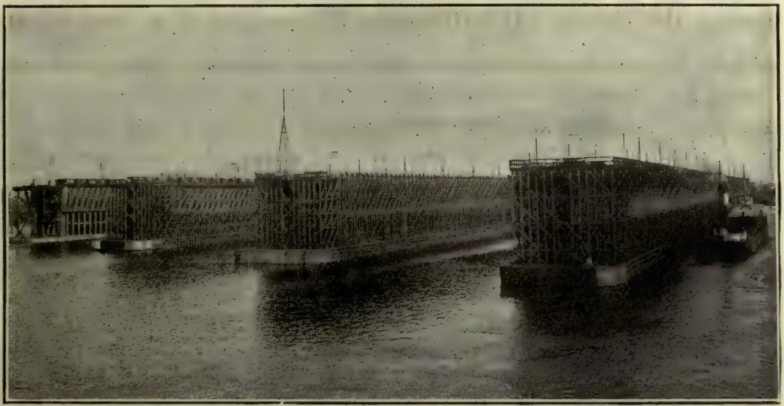


Fig. 30. — Iron ore docks (Superior, Wis.), where iron ore is received, stored, and loaded into steamships. (*Courtesy Oliver Iron Mining Co.*)

Range in Minnesota, north of Duluth. This is the open-pit mining region referred to in an earlier paragraph. This single range produces more than half of the iron mined in the United States, and nearly one-fourth of that mined in the world. The leading states and the per cent of the nation's production mined in them are as follows:

Minnesota, which produces about 62 per cent.
Michigan (Upper Peninsula), about 25 per cent.
Alabama, around Birmingham, about 8 per cent.

In the terms of peace following the World War, France regained Lorraine and its very rich iron mines. France, therefore, is likely to become a greater producer of iron than Germany.

Spain, Sweden, Belgium, Japan, Brazil, Cuba, and many other countries also have valuable iron deposits, though they produce much less than any one of the four leading countries, the United States, Great Britain, France, and Germany.

Copper

Uses. — In its importance to man copper is second to iron among the metals. It enters into the making of a host of ar-

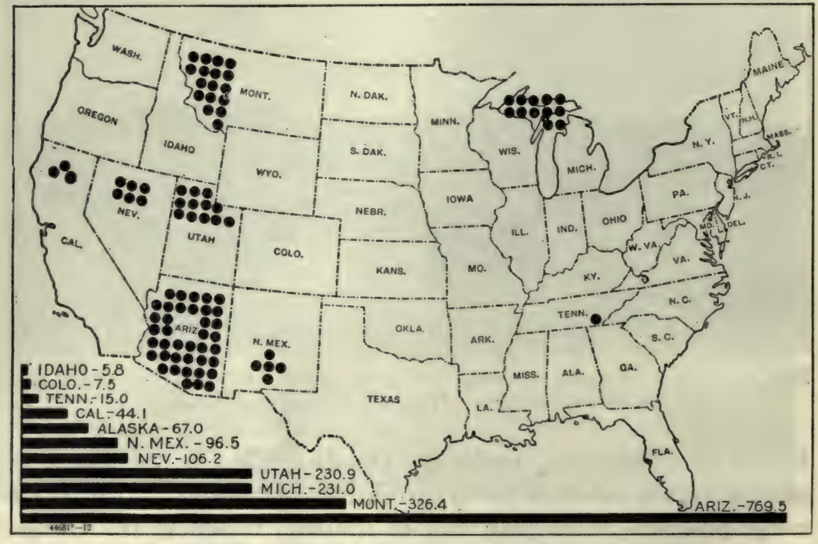


Fig. 31. — Principal copper-producing states. Each dot represents one per cent of the total production of the United States. Figures after names of states signify millions of pounds produced in 1918, which was the year of second greatest production to date (1922).

ticles, the most important of which is copper wire for carrying electric currents. Copper is such an excellent conductor of electricity that it is used in all kinds of electrical appliances and machinery, — telephone, telegraph, electric lights, electric cars, motors, dynamos, and many others. In most copper ores the

metal is combined with other substances, from which it must be separated by smelting and refining.

Where Our Copper Comes From. — In the northern peninsula of Michigan nearly pure metallic copper is mined, masses of the metal weighing hundreds of tons being occasionally encountered in the mining operations. The mines reach more than a mile down into the earth and have yielded upwards of 5,000,000,000 pounds of copper.

More than half the copper annually produced in the world is mined in the United States. It is mined to some extent in 25 states, but nine-tenths of our output (equal to half of the world's production) comes from four states — Arizona, Montana, Michigan, and Utah — and some 65 per cent comes from four mining regions[1] (Fig. 31).

Gold

Value. — Its rich and beautiful color, its rarity, and the ease with which it may be made into any shape have caused gold from earliest times to be esteemed a precious metal; it is not, however, the most costly. Gold is worth about $20 an ounce, platinum several times as much, and radium hundreds of times as much. Gold coin is the standard of value in nearly all countries.

Occurrence. — Gold exists in exceedingly minute quantities in many rocks. It has been estimated that on an average gold forms one part in a billion of the earth's crust. In deep-seated rocks it may possibly exist in larger quantities. Through the pores and fissures of such rocks hot waters and vapors have circulated; it is believed that under favorable conditions these hot waters and vapors dissolve some of the gold and other minerals, and, upon rising and cooling, they deposit these dissolved minerals in fissures near the surface, slowly filling them and making *gold-bearing veins*. Such veins may be only a small part of an inch in width or they may be, in rare cases, hundreds of feet wide; they vary from a few feet to many miles in length.

[1] Butte, Montana; northern Michigan; Bisbee, Arizona; and Bingham, Utah.

Placer Deposits. — When the rocks containing such gold deposits are eroded by streams, the current carries the eroded material downstream and deposits the sand, gravel, and gold in deltas, bars, and alluvial fans, which are called *placer deposits*, or simply *placers*. In placer mining the grains and nuggets of gold are obtained by a process of washing which separates the gold from the lighter sand and gravel.

Distribution. — South Africa is the greatest gold-producing

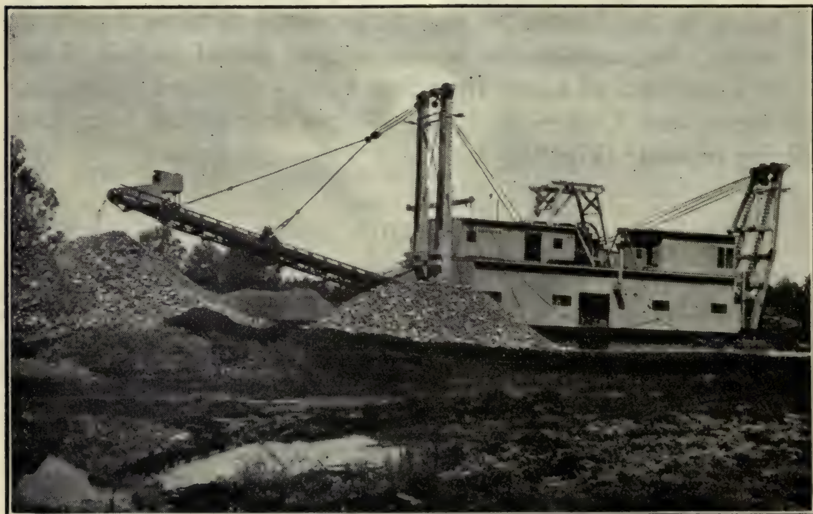


FIG. 32. — A gold dredge in California. Gold-bearing gravels are dredged up, the gold extracted, and the tailings thrown out at the rear; $75,000,000 in gold has thus been recovered in California. (*U. S. Bur. of Mines.*)

region in the world, followed in order by the United States and Australia. California and Colorado are our leading states in the production of gold, but it is mined in twenty other states and in Alaska. The United States produces from $60,000,000 to $80,000,000 of gold annually, a large sum, yet it is less than one-tenth of the value of the petroleum, and not one-twentieth the value of the coal produced in the United States.

Petroleum

Origin. — It is believed that petroleum was formed during past ages from lowly forms of plants and animals. Natural gas usually occurs in the earth in connection with petroleum, the two being held under great pressure beneath an impervious cover of fine-grained rock, such as shale. If it had not been that this

Fig. 33. — The petroleum-producing districts of the United States. The figures indicate percentage of the total which the various states produced in 1919, except in case of 47, which applies to the field included in Oklahòma, Kansas, and Missouri.

impervious roof prevented the gas and oil from escaping, they would long ago have been lost.

Oil Wells. — Sometimes when a well is drilled through these overlying beds of shale, the pressure of the gas drives the oil upward with terrific force. One well in Mexico spouted at the rate of 150,000 barrels a day for a week, sending a stream of oil 600 feet into the air. The pressure soon subsides, however, and in a few months or years, the oil has to be pumped, the wells yield-

ing less and less each year. Seven years has proved to be the average life of a well in Pennsylvania. Exceptional wells yield hundreds, even thousands, of barrels a day for a time, but the average of all wells is only four or five barrels a day. Though sometimes called "coal oil," petroleum has no necessary connection with coal. It is found in regions where there is no coal, as, for example, in southern California.

Where Produced. — The United States produces about two-thirds of the petroleum used in the world, and the Mexican fields near the Gulf of Mexico are the second largest producers. Many of the Mexican wells are "gushers" or very large producers: 300 wells in Mexico yield one-sixth as much as 200,000 wells in the United States. The Russian field near the Caspian Sea ranks third.

For some years after the discovery of oil in 1859, all our petroleum came from Pennsylvania, which still has a very high record among the states in *total* production. Some years ago there were from 40,000 to 50,000 producing wells in that state, but the output has declined to 2 per cent of the annual production of the United States. Two counties in northwestern Pennsylvania had over 14,000 wells each, but the majority of these have been abandoned.

Petroleum is produced in about twenty of our states (Fig. 33); the Kansas-Oklahoma field produced 40 per cent and California 29 per cent of the nation's output in 1920. New oil fields are discovered almost yearly and old fields decline.

Refining and Transportation. — The fact that petroleum is a liquid and that it has to be transported in enormous quantities has led to the building of specially designed tank wagons, tank cars, and tank steamers, and also to the laying of thousands of miles of pipe lines (Fig. 34). Oil is pumped through these pipes from the oil fields to the refineries, and from the interior of the country to the exporting cities on the seacoast. The refining and sale of the products of petroleum have built up one of the richest and most powerful corporations in the world.

Uses. — Crude oil is used for fuel in engines and locomotives,

especially in the Far West and Southwest, where coal is scarce. It is now preferred for large ships because it is less bulky than coal. By refining it a great number of products are obtained; chief among them are kerosene and gasoline. The uses of the former

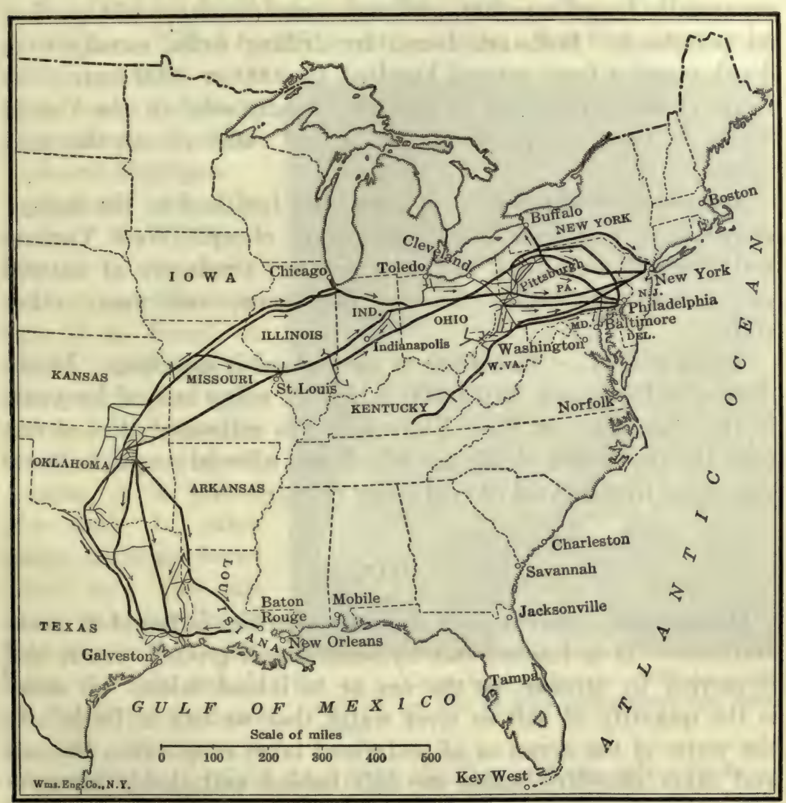


FIG. 34. — Some of the trunk pipe lines by which petroleum is carried from the oil fields to the refineries and to the coast.

for lighting and of the latter for power are two of the boons to civilized man in the last generation. The list of by-products of petroleum reaches over 300; among these are paraffin, vaseline, lubricating oil, naphtha, tar, and coke.

Natural Gas

Origin. — The same agencies which have formed petroleum in the rocks of the earth have also produced natural gas. The two are usually found together, although some districts yield gas but no petroleum. Both are found by drilling wells, usually to a depth ranging from several hundred to 2000 or 3000 feet. The value of the natural gas at present actually used in the United States is twice as great as the annual value of all the gold mined.

Regions of Production. — It is an ideal fuel, and in the regions where it is produced it is surprisingly cheap. West Virginia and Pennsylvania have been the greatest producers of natural gas, followed by Ohio, Kansas, Oklahoma, and many other states.

Waste of Gas. — The waste of natural gas is appalling. In one district in Louisiana, 70,000,000 cubic feet a day burned for years in the open air. In West Virginia it was estimated that at one time the fuel value of the gas which was allowed to go to waste was equal to a carload of coal every minute.

Salt

Occurrence.—Salt in very minute quantities is found in rocks and soils. It is leached out by surface and ground waters and is carried by streams to the sea or to inland lakes. So small is the quantity of salt in river water that we call it fresh. As the water of the ocean or of undrained lakes evaporates, the salt and other dissolved solids are left behind and slowly accumulate; they form over 3 per cent of the sea water and as much as 20 per cent of Great Salt Lake in Utah, and of the Dead Sea in Palestine. It has been estimated that 400,000,000 tons of common salt are dissolved in the water of Great Salt Lake, and that every cubic mile of ocean water contains over 100,000,000 tons of salt.

Origin of Salt Beds. — As evaporation goes on for ages, the

water of salt lakes or lagoons becomes more and more saline until the crystals of salt begin to collect on the bottom and sides. Thus, beds of salt were accumulated, always in regions of dry climate. Later these salt beds were covered by strata of clay and sand which in time became sedimentary rocks. The present salt beds are found buried sometimes only a few feet deep, as in Louisiana, but more often many hundreds of feet deep, as in New York and Michigan.

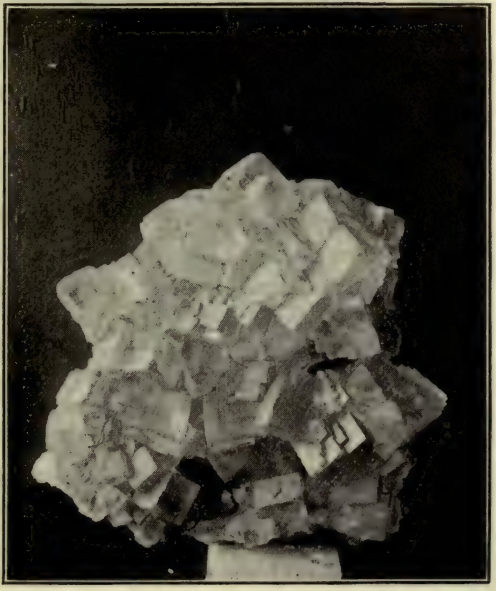


Fig. 35. — Crystals of rock salt. When the salt crystals are able to grow unhampered they form cubes.

Methods of Obtaining the Salt. — Salt is a necessity and it is fortunate that it is found in nearly every part of the world. In some places, as, for example, in Louisiana and in Austria, it is mined like coal. In other places, wells are bored down into the salt beds; water is pumped into the well to dissolve the salt and is afterward pumped out as brine; the brine is evaporated by artificial heat or by the sun, and the salt collects in crystals. The water of Great Salt Lake and sea water on the coasts of California, Italy, Spain, and other places, where little rain falls in summer, is conducted into shallow ponds, where it is evaporated by the sun's heat. In Poland, near Cracow, are enormous salt mines; there are miles of corridors where the salt has been taken out, and there is a village where the miners live underground.

Other Mineral Products

Silver. — Mexico and the United States are the foremost producers of silver. The value of our annual output in 1920 exceeded that of gold. It is nearly all mined in the western states, especially Montana, Utah, Nevada, Idaho, and Colorado.

Lead. — The United States produces about one-third of the lead mined in the world, Missouri and Idaho furnishing 80 per cent of our output. Australia and Spain, the second and third countries in rank, together supply about the same amount as the United States alone. Besides its use in the making of lead pipe, shot, and type metal, it is used in great quantities in the manufacture of paint.

Zinc. — The principal lead- and zinc-mining region of the United States is the Joplin district in southwestern Missouri and extending into the adjacent states of Kansas, Oklahoma, and Arkansas. Northern New Jersey is also a large producer, followed by Colorado, Montana, and Wisconsin. Among foreign countries, Germany and Australia are leaders. Zinc is much used in "galvanizing" iron to prevent rusting, and is an important ingredient of brass and certain paints.

Other Minerals. — In addition to the foregoing mineral products, the United States produces many others, including aluminum, quicksilver or mercury, granite, marble, clay, mineral fertilizers, mineral waters, and limestone for lime and cement (Fig. 28).

EXERCISE V

1. How do the known mineral resources of the United States compare in value with those of any other nation?
2. What minerals are regarded as of greatest value to man? Why not gold and silver?
3. Why is the possession of coal beds of very great importance to a nation?
4. What is the origin of coal?
5. What is peat? Name a country in which it is considerably used for fuel. Suggest a reason why it is used there but not in the United States.

6. Name the several kinds of coal and their chief differences.

7. Where is practically all our anthracite coal obtained?

8. By what process was anthracite coal formed from bituminous?

9. What is meant by *energy?* Why does coal possess a kind of energy? How does man make use of this? Illustrate the working power of coal.

10. What nations have large resources of coal? What fraction of the world's coal is possessed by the United States?

11. Locate and give the dimensions of our most important coal field. What is our foremost coal-producing state? In what other states are large amounts of coal mined?

12. Why is such a high percentage of the coal (90 per cent) mined east of the Mississippi River? How is this fact connected with our manufacturing industries?

13. Note in Fig. 20 how small a proportion of the "coal measures" the coal itself actually forms. Estimate the proportion as shown in this drawing.

14. What per cent of the rocks of the earth's crust is iron?

15. Of the hundred or more minerals that contain iron how many are mined for their iron?

16. By what process are iron deposits "concentrated" or rendered rich enough in metallic iron to make their mining profitable?

17. Give an account of the methods by which iron ores of the Mesabi region are mined and transported.

18. Where are the principal centers of iron-smelting? How is iron smelted? Why is most of it smelted east of the Mississippi? Why near the Great Lakes? Why so largely in Pennsylvania and Ohio?

19. What are the principal iron-mining states? About what per cent does Minnesota produce?

20. What foreign countries mine large quantities of iron? What is the leading iron- and steel-making city of the United States?

21. Why is copper much more extensively used than formerly?

22. What four states supply most of our copper?

23. By what natural processes have gold veins originated? What are "placers"?

24. Where are the most productive gold mines of the world? Which ones of our states are the leading producers of gold?

25. Compare the value of the gold and of the coal annually mined in the United States.

26. What is believed to be the origin of petroleum? With what other valuable fuel is it often associated? Is there any reason for calling it "coal oil"?

27. How is petroleum obtained? How transported? Where are the chief oil fields? What states lead in oil production?

28. What fraction of the world's petroleum is obtained in the United States? What country is second in production? third?

29. Name several products which are made from petroleum. Two of these have exerted a great influence upon modern life. Explain.

30. How is natural gas obtained and for what is it used? Why is so much wasted?

31. Where does the salt in the sea come from? What is the origin of the salt beds in the earth? How is salt obtained? Where? For what is it used?

32. Where in the United States is silver extensively mined? lead? zinc? For what is each used?

CHAPTER IV

ROCK WEATHERING AND SOIL

The Atmosphere

Composition of the Atmosphere. — The atmosphere is composed mainly of two gases, nitrogen (about four-fifths) and oxygen (about one-fifth). Nitrogen is one of the most passive elements in nature, showing little tendency to unite with other elements. Oxygen, on the contrary, is very active; it has an affinity for nearly every other element; that is, the molecules of oxygen have a strong tendency to unite with molecules of other elements. It is the life-giving substance of the air; without it neither man nor the lower animals can live; it causes fires to burn, wood to decay, iron to rust, and rocks to crumble. In addition to the oxygen and nitrogen, there is a fraction of a per cent of carbonic acid gas (or carbon dioxide), and small amounts of water vapor, dust particles, and some other substances. The large proportion of inert nitrogen makes the atmosphere far less active than it would be if the oxygen were present in greater quantity.

You are to think of the atmosphere

(*a*) as being very light and very easily set in motion;

(*b*) as penetrating into the soil and rocks and water;

(*c*) as being capable of absorbing, holding, and carrying heat and water vapor;

(*d*) as containing the exceedingly active gas, oxygen, which is absolutely essential to animal life, and a small fraction of carbonic acid gas, which is required by green plants;

(*e*) as causing many important changes at and near the surface of the lithosphere.

A World without an Atmosphere. — What would be the nature of a world without an atmosphere? The moon is such a world and is so near that with large telescopes we can see its surface; on the moon no wind ever blows, no sound ever floats, no dust ever rises, no clouds ever form, no rain ever falls — for none of these phenomena can occur without an atmosphere. There is no water on the moon; and without air and water rocks do not decay and soil does not form; there are no storms, no dew nor

Fig. 36. — Weathering of a granite dome in the Sierra Nevada Mountains. (*U. S. Geol. Sur.*)

ice, no streams to gully the mountain sides, no rivers to carry sediment. On a planet without air and water no animal can live, and not a blade of grass or a shrub or a tree can grow. Lofty mountains rise above the plains of the moon, but they probably stand almost unchanged from age to age, for the air and the water, the two agents that ceaselessly attack the surface of the earth, have no existence there.

In contrast let us now consider the work performed by our atmosphere and by the water that it distributes.

Weathering

The Agents of Waste. — The wind, rain, frost, changes of temperature, underground water, plants and animals, all grouped together, are called the *agents of waste.* Naturally these agents do their work, called *weathering,* at the surface of the lithosphere.

Fig. 37. — Drifts of wind-blown sand. (*U. S. Geol. Sur.*)

On bare hill slopes and mountains, unprotected by vegetation, they do their work with greatest ease and greatest rapidity (Fig. 36). Where the rocks are covered with a protective layer of soil and carpeted with vegetation, the agents of waste do their work much more slowly.

Wind Work. — The work of the wind, slowly wearing away the rocks, goes on chiefly in regions where rainfall is light and vegetation sparse. In these dry, bare lands the wind sweeps up the sand and drives it against exposed faces of the rock, wearing and polishing them and slowly destroying them. It has been

estimated that in a severe wind storm in such a region there are upwards of 100,000 tons of dust and sand in a cubic mile of the lower air (Fig. 37). In arid regions fence posts and telegraph poles are cut off just above the ground by the constant action of the blowing sand, and rocks are sometimes carved into grotesque forms (Fig. 38).

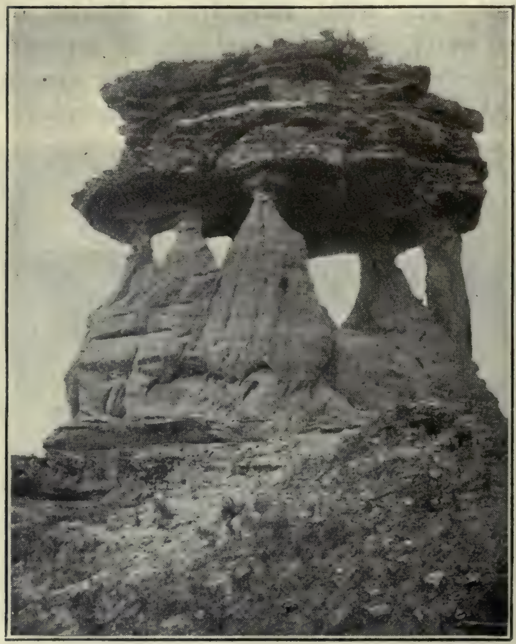


Fig. 38. — Peculiar erosion of rocks due to the prolonged action of sand driven by the wind. The least resistant parts of the rocks are worn away most rapidly.

Rain Work. — When rain falls upon the hills and mountains, it washes any loose rock waste down their slopes and thus uncovers the surface of the rock and exposes it to further attacks of the weather (Fig. 36). The rain itself, beating upon the softer parts of the rocks, wears them slightly and aids in their slow destruction. Here again it makes a great difference whether or not the slopes are covered with vegetation. The rain has but little weathering or eroding effect where grass or woods cover the ground.

Frost Work. — All known rocks are full of tiny pores and are more or less cracked and fissured, so that water and air penetrate them. When it is cold enough, the water in the rock freezes, and in so doing expands with tremendous force, thus becoming a powerful agent in splitting rocks. It has been computed that this force is equal to 300,000 pounds per square foot.

This means that if 2000 average persons could bring all their weight to bear on a square foot of surface, the expansive force of freezing water could lift them. On steep cliffs large blocks of rock, as well as small fragments, are split off by the frost and, sliding to the base of the cliffs, build up sloping heaps of broken rock called *talus* (Fig. 39). On gentle slopes and on plains frost work is less effective, yet by splitting the rocks into pieces it hastens their decay and aids in the making of soil. This form of weathering, due to the force of freezing water, is called *wedge*

FIG. 39. — Remnant of a sheet of lava forming a butte. The weathered fragments form the talus slope. (*U. S. Geol. Sur.*)

work. An idea of its power may be gained by tightly corking a bottle which is completely filled with water, and then allowing it to freeze. Wedge work cannot, of course, go on where the climate is always warm.

Changes of Temperature. — When a solid substance such as iron or rock is heated, it expands, or becomes larger. When cooled, it contracts, or becomes smaller. These changes are com-

paratively slight and cannot be noted by the eye, yet the force exerted is practically irresistible.

When the sun's rays beat down upon the bare face of a rock it becomes hot, sometimes very hot, but the heat does not penetrate far into the rock. Thus the outer part expands and contracts more than does the inner part, and finally pieces of rock scale off, and sometimes large rocks are split asunder. The more extreme and the more rapid the changes of temperature, the greater the amount of weathering done (Fig. 40). In deserts, where the air is very dry and clear, the difference between the temperature of day and of night is more marked than it is in a moist climate. Travelers in deserts tell of hearing sounds like the report of a gun due to the bursting of rocks that are being heated or cooled rapidly.

Fig. 40. — A bowlder weathering by exfoliation, — that is, by the scaling off of one layer after another under the influence of changing temperature and possibly of frost action. (*U. S. Geol. Sur.*)

Work of Plants and Animals. — The roots of trees have remarkable power to push their way into crevices in the rocks, and as the roots grow larger they split the rocks, prying them apart, and thus exposing new surfaces to the weather (Fig. 41). Burrowing animals like the gopher and woodchuck, earthworms and other forms of animal life, as well as lowly plants like mosses and lichens, all do a little toward the breaking up of the rocks and the mixing of the rock waste. The work done by a single animal or plant would not be worth mentioning, but the combined work of millions during long ages is enormous in extent.

Mechanical and Chemical Work of the Atmosphere. — Such processes as the wearing away of rocks by wind or water, or the splitting of rocks by frost, heat, or roots, are called *mechanical processes.* They simply reduce the rock to smaller fragments, and these differ from the original rock only in size, not in composition. There are other forms of weathering, however, in which the rock is not only reduced to small pieces, but its composition is changed; that is, it decays. This is not a mechanical, but a *chemical,* change. The rusting of iron, the decaying of wood, and the souring of milk are other examples of chemical changes.

FIG. 41. — A bowlder split asunder by the growth of the tree's roots. (*U. S. Dept. of Agr.*)

The Decay of Rocks. — The oxygen and the carbonic acid gas of the air, aided by the water, are most important weathering agents. Rocks are made up of interlocked crystals or of grains and fragments bound together by natural cement. When this cement is loosened by the action of the air and water, the grains fall apart, causing the rock to crumble. Thus air and water, by working their way into the pores and crevices of the rocks, produce these changes called decay (Fig. 42). One of the clearest evidences that weathering agents are at work upon a rock is its gradual change in color. Rust-colored stains, due to the work of oxygen and water upon grains of iron in the rock, appear, and the piece of rock begins to look old and soft. Perhaps a blow with a hammer will shatter it. Farmers call it rotten stone, and, in fact, such it is.

Depth of Decay. — The depth to which the bed rocks decay

varies with different conditions, climates, and kinds of rock. In a warm, moist climate decay goes on rapidly. In some of our southern states rocks are known to be decayed to a depth of 100 feet, and it is reported that in parts of Brazil they are decayed to a depth of 300 to 400 feet. These are probably extreme cases. Usually the layer of decayed rock is a few yards or less in

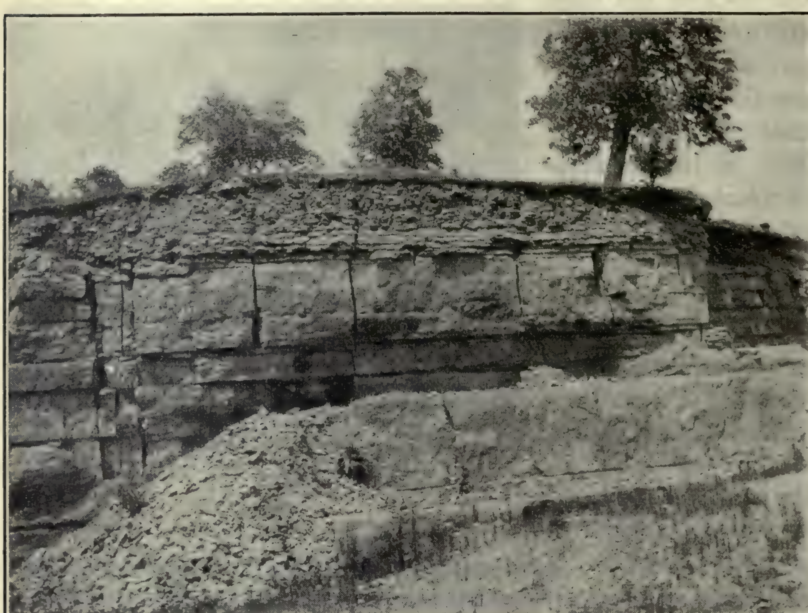


Fig. 42. — Weathering of rock. Note the disintegrated top layer, and the pile of weathered fragments that have dropped to the base of the cliff. The top layer is residual soil. (*Wis. Geol. Sur.*)

depth. This does not mean that the rock has been weathered to only a few yards in depth, for much of the weathered rock has been washed away, or carried away in the ground-water. For example, in a part of Wisconsin, where limestone has been decaying for ages, it is estimated that less than a foot of soil remains for every ten feet of the original limestone, the balance having been carried away by water.

Weathering and Soil. — Disintegrated rock, no matter how fine, is not necessarily soil; the addition to this rock waste of decayed animal or vegetable matter, called *humus*, makes it soil. Since the weathering of rocks by the atmosphere is necessary to produce soil, and since soil is necessary to produce the food upon which we live, it follows that *the second great service performed for man by the atmosphere is the making of soil.*

Other Effects of Weathering. — Besides soil, there are other products of rock weathering which are valuable to man. *Sand* is required in making glass, mortar, and concrete; and *clay* in

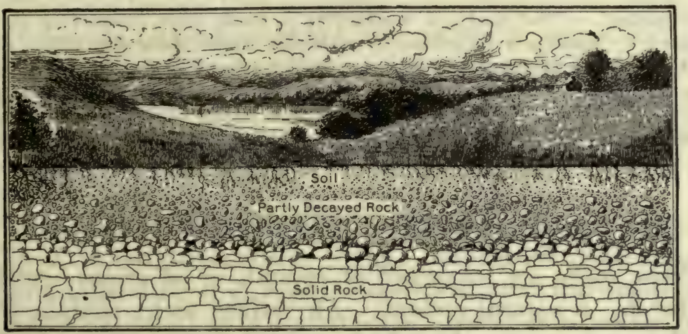


FIG. 43. — A cut into the earth. In this figure notice the *soil* on top, partly decayed rock lower down, and *solid rock* below that.

making brick, tile, and pottery. Weathering agents etch the mountain ridges into peaks, domes, and pinnacles. The softer and weaker parts yield first, forming notches in the ridge, while the firmer portions resist and stand up as peaks. Some of this work is done by running water and the process is then called *erosion.* Weathering and erosion work together and both are most effective on the bare rocks and steep slopes of mountains (Fig. 36).

Injurious Effects of Weathering. — Weathering is by no means always beneficial to man's interests. The air attacks the wood and softens the stone of his buildings; it rusts the iron of his bridges and corrodes many of the metals. To prevent this, man paints the wood of his houses and the iron of his bridges. For

his expensive stone structures he selects a rock, such as granite, that will long resist the attacks of the weather. Weathering is much harder to combat in a warm, moist climate than in a dry or cool climate. In hot regions railroad ties, rails, and other equipment deteriorate rapidly. The Egyptian obelisk, called Cleopatra's needle, which had remained practically uninjured for 3000 years in the dry air of Egypt, began to scale almost immediately after it was set up in the moist climate of New York, and it had to be coated with a protective varnish to prevent the destruction of the hieroglyphics carved on its sides.

Suggestion. — The study of weathering is made more interesting and impressive by making a collection of materials which show the action of the weather. Interested pupils will secure small pieces of fresh iron and of rusted iron, of sound wood and of decayed wood, of firm rock and weathered rock. It is possible to find pieces of rock in various stages of weathering or decay, showing gradations from firm rock to completely disintegrated rock.

Summary of Weathering

Most rocks are composed of crystals or of grains bound together by a natural cement. All surface rocks contain pores, cracks, and crevices by which air and water enter. Oxygen, carbon dioxide, and water attack the rocks, loosen the grains or crystals, and the rock slowly crumbles. In dry regions wind-driven sand wears away the exposed rocks and gradually destroys them. The rain washes away loose material and keeps the surface of the rock exposed to the weather. Water in the cracks freezes (in our climate), expands, and splits the rock (wedge work). The expanding and contracting of the rocks by heating and cooling weakens them and causes them to scale off and to split; trees send their roots into cracks and pry the rocks apart; all these agencies produce the important effect known as *rock weathering*.

Weathering goes on most rapidly in mountains where the loosened fragments slide down the slopes or are washed down, thus exposing the rocks anew to the attacks of the weather. In

comparatively level regions the weathered rock may accumulate to a considerable depth, but usually the larger part is carried away in the ground water or is washed away by streams. The most important result of weathering is the production of soil, which is rock waste mixed with humus. Not all weathering is beneficial; the decay of wood and the rusting of iron are kinds of weathering which man has to combat.

The Soil

Importance of the Soil. — More people, the world over, live by cultivating the soil than by all the other occupations combined. In the densely peopled lands of China and India, about four people in every five cultivate little patches of land, from which they derive their living. Even in such highly developed nations as France and Germany, nearly half of the people live by farming. In our own country one-third of the people who are engaged in gainful occupations are farmers or farm hands.

The Importance of Agriculture. — Agriculture lies at the foundation of all industries, for by it the 1,600,000,000 of the world's people are fed. Food in ever increasing amount the world must have, and practically all of it must come, directly or indirectly, from the soil. The farmer is our greatest manufacturer, and the land is the greatest of all factories. Here the raw materials — air, water, sunshine, and mineral matter — are manufactured into food; moreover, this is a factory that can go on producing food century after century, as the soil of China has done for 4000 years.

The Soil Our Greatest Producer of Wealth. — Vast as is the value of the gold, silver, copper, iron, coal, and other materials taken from the mines and quarries of the United States each year, all of this put together amounts to only one-fourth of the annual value of our farm products; the Secretary of Agriculture estimates this at 10 billion dollars a year, and more than this in the war years 1917 and 1918. Our cotton crop alone is worth more than the annual output of gold, silver, and precious stones of the entire world. Our corn crop exceeds in value the annual

exports of all the countries of South America. Although we have a population of over a hundred million people whom we must feed, we are still exporting great quantities of food; this is partly because the United States is a big country. When all of our possible farm lands are tilled, even with the average care that is employed in France or England, our crops will be enormously increased. A third of the people of the world live in China and India, and nearly all of their food is produced on an area smaller than the United States.

Chief Components of Soil. — The rock waste which forms the bulk of the soil is composed largely of clay and sand, the principal substances into which rocks weather. *Clay* is exceedingly fine; it constitutes about one-fourth of average soil and gives to it its sticky quality. Most of the mineral food of plants is obtained from the clay and almost none from the *sand*, which is largely made up of grains of a very hard, glassy substance known as *quartz*. Sand is a useful part of the soil, for it helps to make the ground loose, porous, and easy to till. *Loam* is a mixture of clay with sand or gravel and humus, and is one of the best forms of soil.

The Humus. — When leaves, straw, roots, etc., decay in the soil, or when animal waste is added to the soil, they give to it the substances stored up in their own tissues, much of which was originally taken from the soil. This animal and vegetable matter forms what is known as *humus;* it makes the soil dark colored and loose and easily penetrated by air, water, and roots of plants. The layer of black top-soil, rich in humus, is the most productive part.

The Work of Animal Life in Improving the Soil. — Earthworms, small as they are, are important agents in improving the soil. Charles Darwin made a study of this subject, particularly in Australia, and found that the millions of earthworms, passing earth through their bodies, mix it, add fertility, and make it porous. He estimated that on an average eleven tons of valuable organic matter are added yearly to each acre of soil where the earthworms are abundant. Burrowing animals and some

species of ants also help to mix and loosen the soil. These creatures seem to be of trifling importance, but myriads of them, steadily working through the ages, have done probably much more than is realized toward improving the soil.

FIG. 44. — Nodules on a root. These are due to nitrogen-fixing bacteria. The nodules are composed in part of nitrogen taken from the air and stored up in a form that plants can use. (*Peabody and Hunt.*)

Importance of Soil Bacteria. — This mixture of rock waste and humus, called *soil,* is not the simple thing it seems to be; it is a wonderfully complex substance, teeming with millions of minute, living things, *soil bacteria.* In a thimbleful of good soil there are countless microscopic plants, multiplying and dying so fast that forty or fifty generations begin and end their existence in a day; yet they do an important work in the short span of their lives. Most of these bacteria are beneficial, but not all. One of the most valuable recent discoveries is that certain bacteria take nitrogen from the air and produce a fertilizing substance, called *nitrates,* which accumulate in the soil. Some of the bacteria occur on the roots of plants, especially plants of the clover family (Fig. 44). When these roots decay, the nitrates are added to the soil. Thus, by raising crops of clover and alfalfa, soil fertility is maintained, or even increased. The nitrogen-fixing bacteria thrive best in warm, loose, airy soil; moist but not water-soaked.

Soil Substances Needed by Plants. — There are at least ten different elements that must exist in the soil to insure healthy plant growth.[1] Potash, phosphorus, and nitrogen are the ones

[1] These are oxygen, hydrogen, carbon, nitrogen, phosphorus, sulphur, iron, potash, lime, and magnesium.

of greatest importance; yet they form but a very small part of the soil, and, with unscientific methods of farming, may be rapidly used up. By placing mineral fertilizers and animal and plant waste on the land, the fertility is maintained.

Residual and Transported Soil. — As rocks decay, some of the soluble minerals are leached out by ground-water; parts may be washed away or transported by the wind, but usually some remains where it is formed and in time makes a layer of soil on top of the slowly decaying rock. This is called residual soil (Fig. 42). Some residual soils, especially in limestone regions, are remarkably fertile. The famous Blue Grass region of Kentucky, and the great Appalachian Valley are instances. Others are infertile, for example, the sandy soils yielded by sandstone.

Soils Transported by the Wind. — Some of the rock waste is blown by the wind and builds up sand dunes and hills, such as the sand hills of Nebraska; or, under special conditions, spreads out a rich, fine soil called *loess,* as in the upper Mississippi Valley and in China. Because of its fineness and fertility, loess is the most important kind of wind-blown soil.

Soils Transported by Water. — At times of flood, rivers and creeks overflow their banks and spread a film of *alluvium* over the valley bottoms. Being made up of materials from the surface of the land, alluvium is likely to be of exceptional fertility, as it is in the valley of the Nile or on the "Mississippi bottoms." The alluvial soils of the earth, where they are not marshy, are among the best. Some of the famous flood plains are described in Chapter X.

Soils Transported by Ice. — Glacial soils cover more than half of North America and a third of Europe. It is believed that the glacial soils, on account of their thorough mixing, comparative newness, and varied composition, are better than the residual soils of these same regions would have been. The most productive farming regions of the United States have glacial soils; yet there are also excellent soils in the South and West, where the glaciers did not reach. In parts of eastern Canada and New England, and in scattered localities elsewhere, glaciated land is so

strewn with bowlders that its value is materially reduced; while in parts of Michigan, Wisconsin, and north Germany, the glacial drift is very sandy, and hence is not good farm land. Glacial drift usually contains a large proportion of clay, which makes the basis of an excellent soil. Owing to the relative newness of glacial soil it has lost but little of its mineral plant-food by leaching.

Soil-Creep. — As the soil on the slopes freezes and thaws, or is otherwise loosened, gravity tends to pull it down the slope. By this almost imperceptible *creep*, soil gradually works its way down the steeper slopes from the uplands to lowlands.

Fig. 45. — A bare rock slope gullied by wet-weather streams. If soft rock or soil is unprotected by a covering of vegetation, the agents of weathering and erosion work upon it effectively. (*U. S. Geol. Sur.*)

Soil-Wash or Erosion. — On slopes that are not protected by vegetation, the run-off during a rain makes gullies in the land and much of the soil is washed away (Fig. 45). In this way large areas in China, where the forests have been stripped off, have become practically worthless. A movement is on foot in this country to preserve or restore the forests on mountain sides and other steep slopes, and thus to prevent soil erosion. On ordinary slopes a covering of grass is sufficient to protect the land, and these slopes may properly be given over to the grazing of cattle and sheep. Gentle slopes are cultivated without serious loss of soil by erosion.

The Preference of Certain Crops for Certain Kinds of Soil. — Any fertile soil contains the food required by almost any plant. Differences in climate are more important to plants than differ-

ences in soil, yet certain crops plainly show a preference for certain kinds of soil. *Pastures* and *meadows,* for example, do better on soil which contains a large proportion of clay, for clay retains water, which grass requires, in large amounts. Potatoes and rye grow best in soils which contain much sand; and large areas of the sandy plains of northern Germany, for example, are given over to those crops. Germany, in fact, leads the world in the production of potatoes and is second only to Russia in rye. The *tobacco* used in making cigars is particularly dependent for its flavor upon the character of the soil. A Government bulletin says, "So marked is this influence of soil upon the quality of the tobacco that a fine, bright tobacco land may be separated by only a few feet from a clay soil which will produce only a heavy manufacturing or export leaf." Rice grows in the wet, alluvial soil of lowlands, while the tea plant requires just the opposite conditions, the well-drained slopes of hills. Cotton grows best in black lowland soil, rich in humus; and the coffee of Brazil in the red upland soil, rich in iron.

Forests and Soils. — The kind and quality of trees are largely dependent upon the condition and quality of soil. In northerly regions pines are nearly always found on sandy soils, while clay soils generally produce hardwood trees. In our northern forests differences in the proportion of sand in a soil give rise to differences even in the kind of pine trees that predominate. The poorest of these soils produces the poor Jack pine, while the better soils produce the valuable white pine.

EXERCISE VI

Making a Summary of the Section on Soil

It is suggested that the pupils make a summary of the second part of this chapter. In this instance it may be done as follows: Read the paragraphs carefully one by one and select from each the sentence which seems to contain either the substance of the paragraph or its main idea. For example, in the first paragraph, "Importance of the Soil," this sentence is plainly the first. In some paragraphs a part of a sentence may be selected or parts of two sentences may be combined. In some paragraphs it may be necessary to state the summary sentence entirely in your own language. Write these in your notebook and preserve them for purposes of review.

EXERCISE VII

1. Why is oxygen called an active element and nitrogen a passive element?
2. Why are conditions on the surface of the moon utterly unlike those on the surface of the earth?
3. Why does rock weathering proceed more rapidly on mountains than on plains? on steep slopes than on gentle? on bare slopes than on wooded?
4. Why is wind erosion more important in a dry climate than in a moist one?
5. Why does the rain have "but little eroding or weathering effect where grass or woods cover the ground"?
6. Why is the work of frost called *wedge work?* How is the frost an effective weathering agent?
7. Why do changes of temperature aid in breaking up the rocks?
8. Why do rocks decay?
9. Why is weathered rock not necessarily soil?
10. Why is weathering both beneficial and harmful to man's interests?
11. Why is the soil the most valuable of all natural resources?
12. Why is the soil the greatest of manufactories?
13. Why are we justified in considering the soil of the United States our greatest producer of wealth?
14. Why is clay the most important constituent of ordinary soil? Of what value is sand?
15. Why do soils lose fertility? How may it be restored?
16. Why is humus an essential part of the soil?
17. Why are earthworms a benefit to soil?
18. Why are certain forms of bacteria of great benefit to the soil?
19. Why are some residual soils fertile and others sterile?
20. Why are alluvial soils nearly always fertile?
21. Why are glacial soils likely to be fertile? Are they always fertile?
22. Why does soil creep down hill slopes?
23. Why does cultivation of steeply sloping land soon lead to the loss of soil?
24. Why does Germany devote much of her land to rye and potatoes?
25. Why does the character of a forest give a clew to the quality of the soil upon which it grows?

CHAPTER V

AGRICULTURE IN THE UNITED STATES[1]

Crops and Prosperity. — The prosperity of the American people is more closely connected with agriculture than with any other industry. Nearly a third of our population live on farms. When crops are good, the country's business feels the stimulus, and every other industry shares in the prosperity. The value of our farm products is a fabulous sum, amounting to ten billion dollars yearly. This is three or four times the value of the coal, iron, copper, gold, silver, and other minerals taken from our mines, quarries, and oil fields annually.

The Importance of Weather to Agriculture. — Climate and weather are not the same. The climate of the Middle West, for example, is excellently suited to the growing of corn, yet exceptionally dry weather during the month of July has reduced the corn crop of the United States several hundred millions of bushels. The prolonged drought in the summer of 1913 cost the farmers of the grain-growing states not less than five million dollars a day. A difference of two inches in the amount of summer rainfall may change the wheat crop of the Northwest by 200,000,000 bushels. Hail storms not infrequently damage the crops of a small area at the rate of $100,000 a minute, and violent winds have blown a quarter of a million bushels of apples from the orchards of New York in a single night. These losses are usually distributed over a great number of farms and do not affect all the crops; hence the loss is not so keenly felt as it otherwise would be.

American farmers have prospered greatly in the present generation; farm property in the United States doubled in value between 1900 and 1910, and again increased nearly as much in value

[1] For suggestions on the study of this chapter, see pages 89 and 90.

between 1910 and 1920. Iowa, our most distinctively farming state, has the highest *average* wealth per family of any state in the Union.

Extent of Farm Land. — No other nation except Russia has so large an area of agricultural land as the United States, and even Russia produces much less; but not half the land of the United States is devoted to farms and ranches[1] and only one-

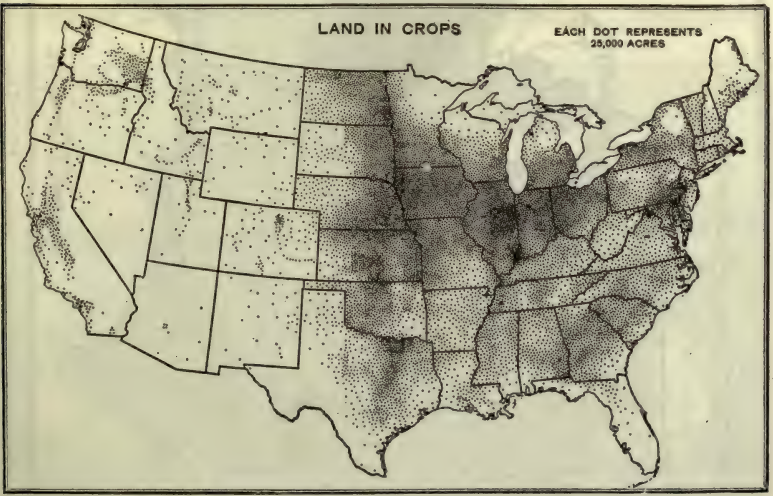


FIG. 46. — Note the high proportion of land in crops in the prairie states and the eastern part of the great plains states. (*U. S. Dept. of Agr.*)

quarter is producing crops. A third of the United States is too dry for agriculture without irrigation and only a small fraction of this third can be irrigated. Swamps, still undrained, cover a total area equal to 15 states the size of Massachusetts, or four per cent of the area of the country; much of this, however, will eventually be drained and converted into productive land.

Yet, when we have deducted all the arid lands, swamp lands, mountains, and other kinds of waste land, and all our forests,

[1] In most parts of the United States west of the Rocky Mountains the term *ranch* is used in place of *farm* even though it may be only a few acres in size.

FIG. 47. — Agricultural provinces of the United States. (*U. S. Dept. of Agr.*)

we still have left an area already in farms equal to the land area of the British Isles, Germany, France, Italy, and Norway combined. We plant more land to corn alone than the entire area of the British Isles, and more to wheat than the area of six Belgiums.

Farming Methods in the United States. — In France the average size of farms is about 20 acres; in Japan it is 3 or 4 acres, but in the United States it is 140 acres. In India, China, and Japan population is very dense and farm labor is cheap. Consequently

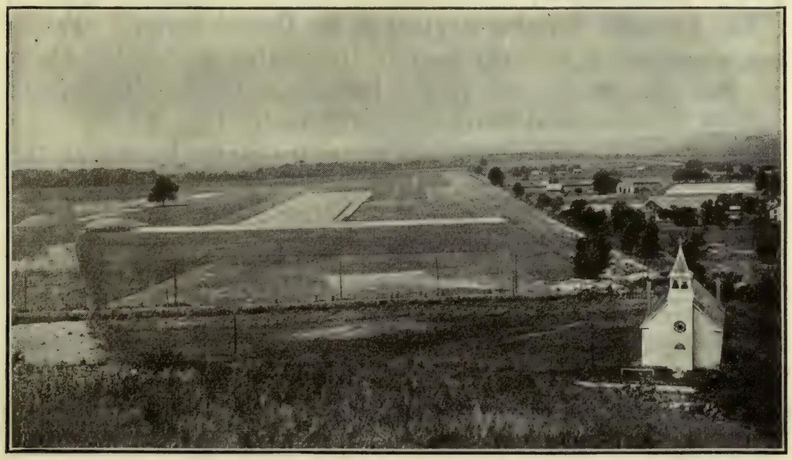


FIG. 48. — The rich, level farm lands of northern Illinois, among the most productive and valuable of the country. (*U. S. Bur. of Soils.*)

most of the work in these countries is done by hand, and it is thoroughly done. In most parts of Europe, outside of Russia, farming is more carefully done than in the United States, for land there is very valuable and must be made to produce all that it possibly can. An acre of wheat in Belgium or England is made to yield on an average twice as much as in this country. But in the United States, where land is comparatively cheap and labor is expensive, machinery is much used; in fact, nowhere else is farm machinery so extensively used as in this country.

Almost every process in farming now has its machine by means of which a large amount of work is accomplished in a short time. For example, in 1830 it required an average of 160 hours of work to produce 50 bushels of wheat, while in 1900, with modern machinery, it required only 7 hours. Gang plows, seeders, harvesters, and steam threshers have made it possible for five men to perform the work which it required a hundred to perform a generation ago. Under this system the yield of crops per acre is smaller than that in western Europe, but the production per man is much greater.

The Principal Farming Regions of the United States. — Farming is carried on in every part of the United States, but there are two great sections where this industry outranks every other; namely, in the central states and in the South (Figs. 46, 47).

The North Central States. — The twelve states known as the north central group, extending from Ohio to the Dakotas, include only one-fourth of our land area, but this one-fourth makes up 60 per cent of the total value of our farm lands, and it produces nearly one-half of the crops of the nation. The farms of two central states, Illinois and Iowa, form one-fifth of the value of all the farms in the 48 states. The north central area includes both the corn belt and the wheat belt (Figs. 49, 50). Here in twelve states we raise almost three-fourths of the grain produced in the United States, and also the larger part of our meat animals.

The South, too, is a great farming section, producing a third of the crops of the country; it has a long growing season, ample rainfall, mild winters, and fertile soil (Fig. 51); it is second only to the central states in the total production of crops; grains are of secondary importance, and neither dairying nor the fattening of live stock is largely followed. Cotton is king; more cotton is grown here than in all the rest of the world. Corn ranks second and is grown on almost every farm; but the warm, moist climate is not well suited to wheat. Land is less expensive, farming is less diversified, and machinery is less used than in the north central states. The large plantations which were once common in

the South have been steadily giving place to farms of moderate size.

THE PRINCIPAL CROPS

Corn is the leading crop grown in the United States; our corn fields would cover the total area of the British Isles and Portugal. Nowhere else in the world is any crop of such magnitude raised (3,000,000,000 bushels in a good year); 70 per cent of

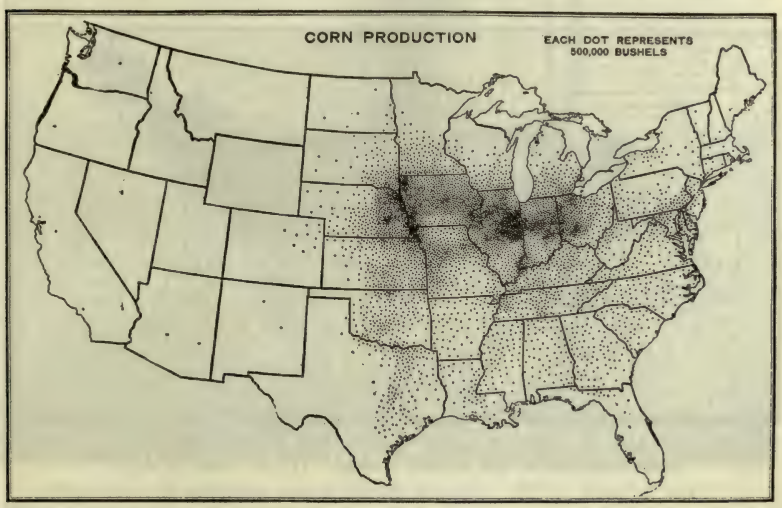


FIG. 49. — Note the east-west extension of the "corn belt" from Nebraska to Ohio. The United States raises more corn than all the rest of the world. (*U. S. Dept. of Agr.*)

this is grown in the north central states, where it is mainly used for fattening hogs and cattle. It will be seen from Figs. 49 and 59 how closely the swine- and cattle-raising states correspond to the corn-growing states. We export little corn; in fact the greater part never leaves the farm where it is grown, except as it finally reaches the market in the form of meat.

Hay and forage are the leading crops in the northeastern quarter of the United States and form our second crop in point of value. Forage is a general name applied to all kinds of grasses and

clovers which are used as a feed for farm animals. Few people realize that the hay and forage crop is more valuable than either cotton or wheat, or that it is the most valuable crop in one-third of the states of the Union. *Alfalfa* is a relative of clover, and is being raised with much success on irrigated lands and in regions of moderate rainfall, such as western Kansas and Nebraska. If necessary, it can send its roots ten or more feet into the ground in search of water, and on moist land it yields three or more crops

FIG. 50. — Cotton-growing region of the United States; this region produces more than half of the world's cotton. (*U. S. Dept. of Agr.*)

a season. It is a highly nutritious feed for farm animals and is excellent for the land because of its ability to add nitrogen to the soil. (See page 65.)

Cotton is the great crop of the South and is the greatest of all our exports. The plant is sensitive to cold and grows only where it can have six or seven months without frost (Fig. 50). It demands a rich soil, a warm, wet spring, abundant sunshine, and a dry autumn for picking. Only one large area in the world meets all the rigid requirements of the cotton crop, and that is the southeastern quarter of the United States; here 60 per cent of the world's cotton is grown (Fig. 50). Standard cotton bales weigh about 500 pounds, and an acre of good land produces

from a half bale to a bale or even more, but the average is about one-third of a bale. These southern cotton fields occupy an actual area equal to that of England. Two-fifths of the crop is exported, half of it going to England and Germany in times of peace. England's greatest industry, cotton-manufacturing, is so dependent upon American cotton that during our Civil War raw cotton in England rose to over a dollar a pound,

FIG. 51. — A southern cotton field in autumn. (*U. S. Dept. of Agr.*)

and many mills, unable to get cotton at any price, were forced to shut down, thus throwing thousands of people out of work.

Sea Island cotton is a superior variety with a long, silky fiber; formerly it grew near the coast and on the islands off South Carolina and Georgia. At present most of it is grown some distance inland in Georgia and northern Florida. In irrigated lands of southern California and Arizona, a variety of long staple cotton similar to the Egyptian is now being grown.

Wheat is our fourth crop in point of value (Fig. 52). Two generations ago western New York was a leading producer, and Rochester was the "Flour City" of America. But year by year the

center of wheat-growing has moved westward, through Ohio, Michigan, Illinois, Wisconsin, Minnesota, and then to Kansas and North Dakota.

Winter wheat, sown in the fall, is the leading variety in all the wheat-growing states except the Dakotas and Minnesota, where *spring wheat* (sown in the spring) is the kind chiefly grown. The highest-priced flour is made from the northern-grown, hard, red variety of spring wheat. In America wheat-growing on a

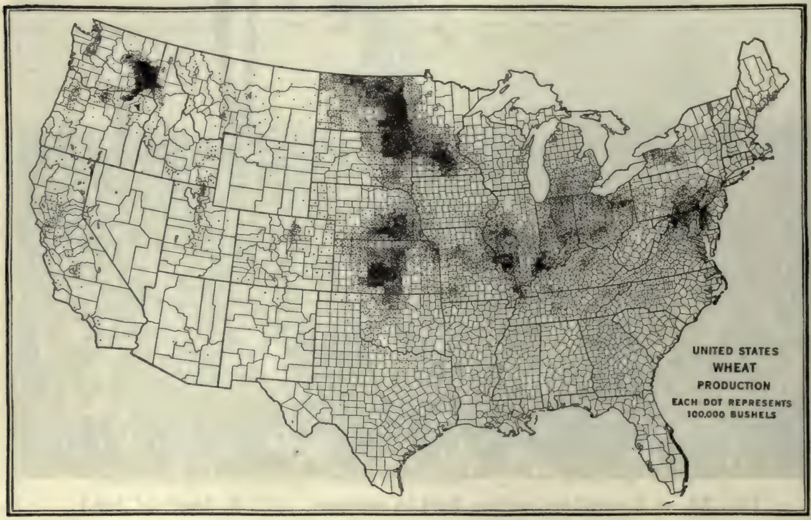


FIG. 52. — Regions of wheat production. (*U. S. Dept. of Agr.*)

large scale has always been on new lands; this accounts for the constant westward movement of the center of wheat cultivation.

Wheat grows all the way from the equator to the polar circle, but it reaches its highest perfection in a cool temperate climate. In America it is the most favored crop for big farms on level plains where machinery can be employed. In the Red River Valley of the Dakotas and Minnesota, and in Washington, farms (ranches) of 1000 acres, or larger, are not uncommon, and in the latter state machines which cut, thresh, and bag the grain at one operation are used (Fig. 53). *The average yield* in the United States

is only about 15 bushels per acre, which is much lower than that in western Europe, but is higher than that in Russia, Argentina, and Australia.

Prior to 1900, and again during the great World War, the United States was a large exporter of wheat, but our increasing population will continue to demand more and more at home, and the time is not far off when we shall become an importer of this

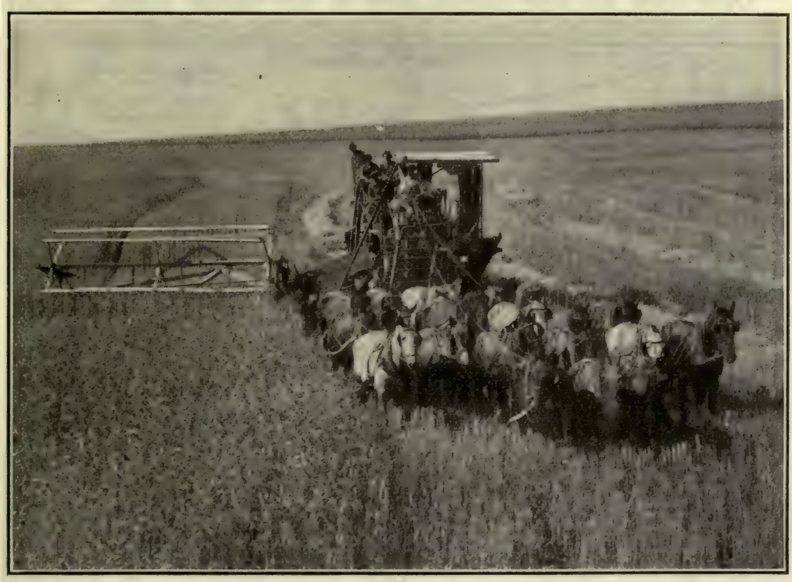


FIG. 53. — Harvesting wheat in Oregon with a combined harvester and thrasher.

grain. The wheat crop of 1915 was the largest ever harvested and reached the enormous total of one billion, or 1000 million bushels, the greatest quantity ever produced by any nation. Europe, as a whole, produces more wheat than North America and South America combined.

Potatoes are an important food crop, raised mainly in the northern states from Maine to Minnesota. They grow best in sandy loam. They require a great deal of work on the part of

the farmer, but a good crop yields upwards of a hundred dollars an acre and may yield four times this amount. Contrast this with wheat, whose yield in this country is usually about $15 an acre, though much more under war prices. Strangely enough, our most noted potato-growing region is far from the great city markets, in northeastern Maine. Figure 54 shows the distribution of the potato crop.

Oats form the fifth largest crop in the United States. Their

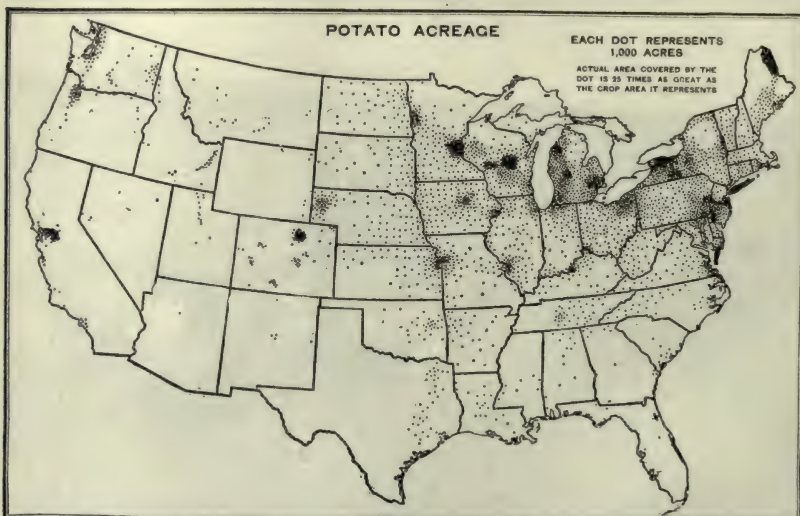


Fig. 54. — Distribution of potato-growing in the United States. (*U. S. Dept. of Agr.*)

principal use is as feed for horses and other farm animals. They are hardy and grow best in a cool climate such as that of the northern United States and southern Canada. It is worthy of note that three out of five leading farm crops (corn, hay, and oats) are raised not for man's direct use, but chiefly as a food for farm animals.

Rice, one of the greatest cereal foods, is not largely grown in America. In the Orient it is the most important of all foods, and a third of the people of the earth are said to eat it every

day. Formerly our principal rice fields were in South Carolina and Georgia, where the planters depended for the irrigation of the crop upon the overflow of streams; now the rice is mostly grown on slightly elevated lands in Texas, Louisiana, Arkansas, and California, where artificial irrigation is practiced, and where the land is firm enough to allow the use of harvesting machinery (Fig. 55).

Sugar Cane and Sugar Beets. — The former is a tropical or

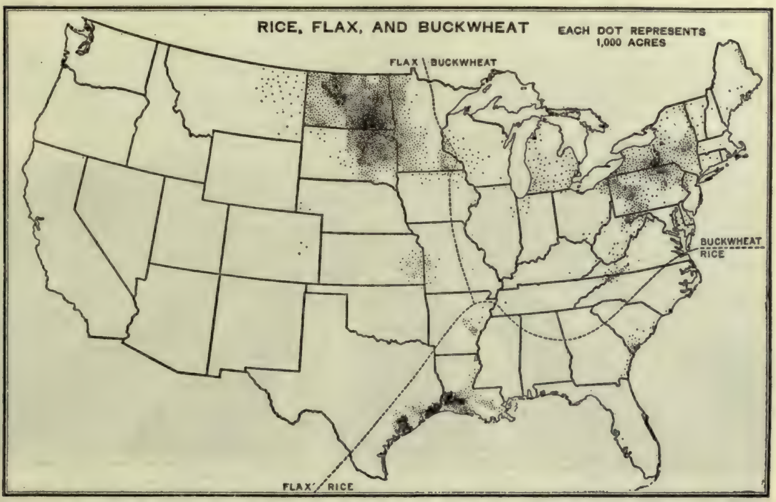


Fig. 55. — The Dakotas produce most of the flax; New York and Pennsylvania most of the buckwheat, and Texas, California, and Louisiana most of the rice. California's production rose rapidly between 1910 and 1920, but is not indicated on this map. (*U. S. Dept. of Agr.*)

subtropical product. Cuba, Hawaii, Porto Rico, the Philippines, and Louisiana supply the larger part of our cane sugar. It can be most profitably grown on large plantations, covering hundreds or thousands of acres, and the industry is therefore one requiring capital. The cane grows to a height of 10 or 12 feet, is cut, and is taken to the mill usually on the plantation, where it is run through rollers to press out the sweet juice, from which the sugar is made by boiling. In years just prior to the World War more sugar was

made from beets than from cane. Sugar beets grow in a cool climate, and Colorado, California, Utah, and Michigan are our largest producers, though far below central European countries.

Barley and rye are cereals produced in much smaller quantities than corn, wheat, or oats.

Tobacco, like Indian corn, was unknown to Europeans until the discovery of America. Since early colonial times tobacco has been an important crop in certain sections of the country,

FIG. 56. — A strawberry field on the sandy soil of the coastal plain of North Carolina; note the levelness of the plain. (*U. S. Bur. of Soils.*)

notably in Virginia and North Carolina, and later in Kentucky; it is also a crop of importance in several northern states.

Fruits. — Scarcely any crop is so sensitive to climate as are fruits. The more hardy ones, like apples, plums, pears, and cherries, will ripen in the northern states, but the citrus fruits, such as oranges and lemons, are subtropical in their habits. Many fruits, such as strawberries, peaches, plums, and pears, must be marketed promptly after picking and so can be profitably grown only in populous regions, or where transportation facilities are especially good.

The Great Lakes exert an important influence upon fruit-growing in their neighborhood, especially in the region immediately east of them (Fig. 205). New York and Michigan are, next to California, the leading states in the production of fruit. Large bodies of water warm up slowly in spring, and, by keeping the surrounding air cool, prevent the early opening of the buds on the fruit trees, which are thus saved from injury by late frosts.

Fig. 57. — Orchards of pears and apples in the Rogue River Valley of Oregon. (*U. S. Geol. Sur.*)

Apples are the most important of the orchard fruits. In their production New York was long the leading state, but Washington now leads. California is foremost in the production of nearly all other fruits, including peaches, pears, plums, prunes, cherries, apricots, grapes, oranges, lemons, figs, and olives. This single state grows as much fruit as the three states next in rank (New York, Michigan, and Pennsylvania). The splendid orchards of California, Washington, Oregon (Fig. 57), and other far-

western states are mostly on irrigated lands, and the brilliant sunshine of the dry summers gives a wonderful richness of color to the fruit (Fig. 58).

The region adjacent to the southeastern end of Lake Erie is the principal grape belt outside of California. Florida grows only a third as many oranges as California, but supplies the greater part of the grapefruit, pineapples, and tangerines raised in this country. The growing of figs and olives and even dates in Arizona and California is increasing, and a few bananas are raised in Florida. Important as fruits are, they form only about four per cent of the value of the crops of the United States.

Stock-Raising and Dairying

Stock-raising. — The raising of crops is only one part of the farmer's work. He usually keeps several horses; dairy cows are kept for milk, and thousands of farms derive their chief income from this source. In the corn belt especially (Fig. 59), but in other parts of the country also, the fattening of beef cattle and hogs is a highly profitable branch of farming. In certain other sections, sheep-raising is common (Fig. 60), and nearly every farm has poultry. There are, in round numbers, 200 million horses, cattle, swine, and sheep in the United States, or nearly twice as many as there are people.

The maps on page 86 show that certain sections of the United States specialize more or less in the raising of certain farm animals.

Cattle. — Large numbers of cattle still graze on government land in the semiarid West. Sheep (Fig. 61) are tended by shepherds, but the cattle belonging to different men are "branded" with the marks of their respective owners and then are allowed to graze at will. In the fall, a "round-up" is held and the different owners and their "cowboys" sort out their own cattle. Most of those that are ready to sell are shipped east; many of them are bought by farmers in the corn belt, where they are fattened and later are sold to the slaughterhouses of Chicago, Kansas City, Omaha, and other meat-packing centers. A great many

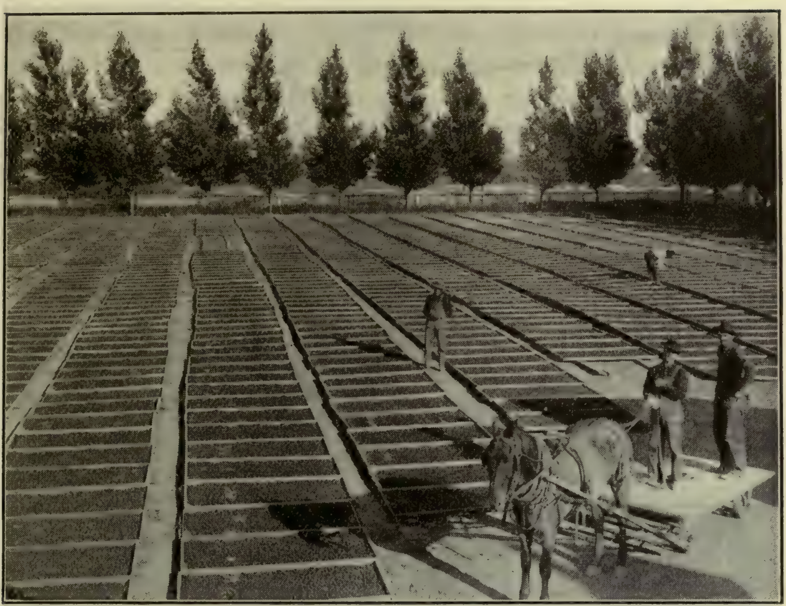


FIG. 58. — Drying fruit in the bright sunshine of southern California.

beef cattle are reared entirely in the corn belt, some being raised on nearly every farm. The United States has been a large exporter of meat, but our own population is becoming so large that we need most of it at home; we have already begun to import meat from Argentina.

Sheep. — The open range, or government land, of the West (Fig. 61) is important grazing land for sheep; the states of Wyoming and Montana have several times as many sheep as they have people. Some of the central states, especially Ohio, also raise sheep, in connection with general farming; yet we find it necessary to import about half of the wool that we use.

Swine. — Pork is one of the principal meats used in the United States, and hog-raising in the corn belt is a vast industry. There are counties in Iowa which average 50 hogs to the farm, while some farms have several times that number; the entire state

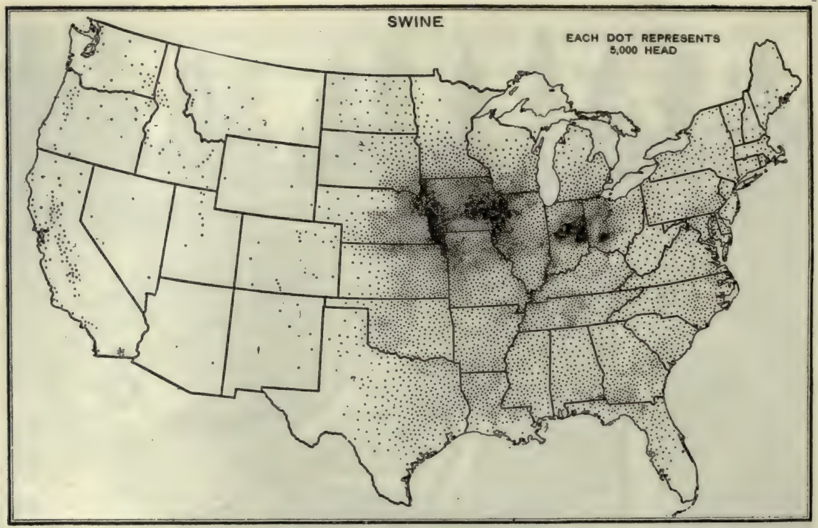


FIG. 59. — Distribution of swine in the United States. (*U. S. Dept. of Agr.*)

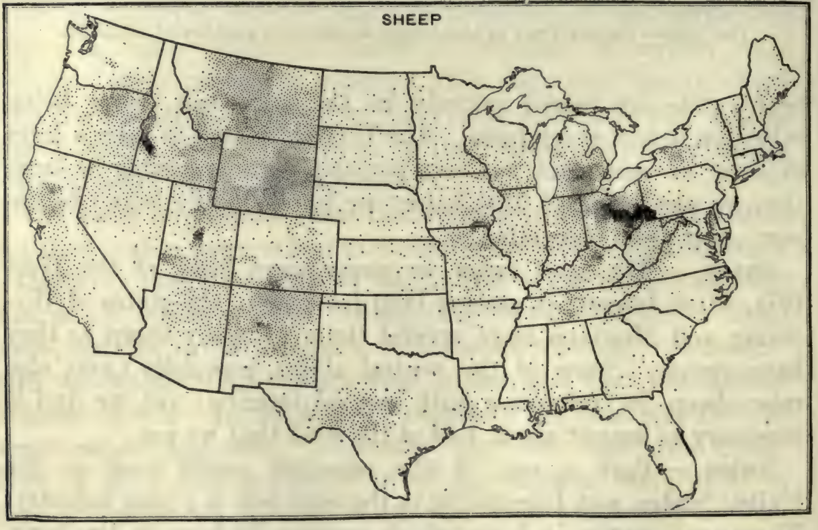


FIG. 60. — Distribution of sheep in the United States. Each dot represents 5000 head. (*U. S. Dept. of Agr.*)

has from 8 to 10 million. Hogs are also raised in large numbers in the South, where corn is the leading cereal. Our export of pork products — hams, bacon, lard, etc. — has been very large in the past but will decline on account of the growing needs of our own population.

Dairying, or dairy farming, is the leading type of agriculture in some states and in many localities. Cities must get their milk from the farms and must get it fresh daily; therefore, it must

FIG. 61. — On the semiarid lands of the West, millions of sheep are raised. (*Physiography Lab. Cornell Univ.*)

be produced at no very great distance. By means of refrigerator cars and special milk trains, New York and Boston are obtaining milk from distances of several hundred miles (Fig. 62).

The making of *butter* and *cheese* is a large industry. The American people use upwards of 5 million pounds of butter every day. The butter made in three states — Iowa, Minnesota, and Wisconsin — exceeds in value the gold output of all North America. The cheese produced yearly in Wisconsin is worth more than the gold mined in the United States; New York and Wisconsin are close competitors for first place in the production of milk. Because of the warmer climate and fewer cities in the South, dairy

farming is followed less there than in the central and eastern states.

FIG. 62. — Dairying regions of the United States. A large part of the milk produced in the eastern states is consumed in the near-by cities. The greater part of that produced in the north central states is made into butter, cheese, and condensed milk. (*U. S. Dept. of Agr.*)

CONDENSED SUMMARY OF IMPORTANT FACTS ABOUT AGRICULTURE IN THE UNITED STATES

1. Agriculture employs more people, produces more wealth, and is more closely connected with the general well-being of our people than any other industry.

2. Nearly one-third of our entire population live on farms. General business prosperity is closely related to the prosperity of the farm.

3. Only one-half of the area of the United States is divided into farms, and about one-quarter is improved farm land; yet the area of our farm land equals the combined area of the British

Isles, Germany, France, Italy, and Norway. (Nearly one-half of the farm land is not improved.)

4. The north central states form our greatest farming section. They comprise only one-fourth of the area, but they raise nearly half of our crops and over half of our live stock. The southern states produce over one-third (35%) of our crops. Illinois and Iowa are outstanding agricultural states. Nearly all of their area is improved farm land, the value of which is one-fifth of the total value of all the farm land in the 48 states.

5. Our five leading crops in order of value are (1) corn, (2) hay, (3) cotton, (4) wheat, (5) oats. Cereals form about half of the value of all crops. The importance of meat production in the United States is shown by the fact that of the five leading crops, three, — corn, hay, and oats, — are raised almost wholly for feeding animals; only one-fourth of our farm crops are raised directly for man's food.

6. Dairying and mixed farming prevail in the older eastern states, cotton-growing in the South, cereal-growing and meat-production in the Middle West, grazing of sheep and cattle in the mountain states, and the growing of fruit and grain in the Pacific states. Dairy farming is most largely carried on in the states near the Great Lakes.

7. Apples are our most valuable fruit, and Washington is the leading producer. Peaches are second, grapes third, and oranges fourth, with California the leader in all three. California produces fruit as great in value as the combined value of the fruit crops of New York, Michigan, and Pennsylvania, the three leading fruit-growing states of the East.

8. Irrigation is being employed in the western states on about one-fifty-fifth of the total farm land of the country.

EXERCISE VIII

Suggestion. — This chapter may appropriately be studied and discussed by the *topical method.* The following topics are suggested; pupils should prepare themselves to give brief talks on each of these.

Discuss: 1. The connection between the prosperity of the farms and the prosperity of the country as a whole

2. The importance of weather to the farmer
3. The extent of our farm land
4. Size of farms and the farming methods in the United States
5. Agriculture in the central states
6. Agriculture in the South
7. The leading crops of the United States and where grown
8. The importance of cotton
9. Wheat-growing in the United States and Europe
10. Sources of our sugar supply
11. Fruit-growing in the United States
12. Stock-raising and dairying in the United States
13. Reasons for the great development of agriculture in the United States

CHAPTER VI

THE WORK AND SERVICE OF UNDERGROUND WATER

What Becomes of the Rain Water? — Think of an irregular land surface upon which rain has been falling. Soon after the rain ceased most of the water disappeared.

1. Some of it ran down the slopes, formed rivulets, and joined a stream on its way to the sea; this is termed the *run-off*.
2. Some of it soaked into the ground.
3. Some of it dried up, that is, was evaporated by the sun and wind.

Some of the run-off and some of the water that soaked into the soil was also evaporated later. Therefore, in the course of time, all the water that fell in this rain went (*a*) to the sea, or (*b*) into the ground, or (*c*) into the air. Every drop had gone through these experiences many times before, for the water which to-day falls upon the earth has fallen in countless other rains during past ages; again and again it has run to the sea, has been evaporated, and has been carried over the land by the wind to fall again as rain.

Depth and Amount of Ground Water. — The rain water sinks easily into the porous soil and subsoil and also into the underlying rocks; but it is believed that at a depth of about twenty miles the great weight of the overlying rocks permits no open spaces in which the ground water may collect. It has been estimated that the amount of water in the ground is sufficient to make a layer 1000 feet deep over all the land surface of the earth. Even if this is true, this would be only a small amount of water in proportion to that in the oceans.

The Ground Water Surface or "Water Table." — In regions of heavy rainfall the ground may be saturated nearly or quite up to the surface, but in dry regions wells must reach down scores

or hundreds of feet to find water. If several wells were drilled in a level plain, all at about equal distances from stream courses, they would probably strike water at about the same depth, and water would rise in all of the wells to about the same level. This level would be the *water table* in that region. That is, the pores and crevices of the rock or soil are filled with water up to that level. In a prolonged drought the water table gradually sinks, and during a prolonged rain it rises. In a dry season the shallow wells often become dry while the deep wells contain plenty of water; this is because the water table has sunk below the bottoms

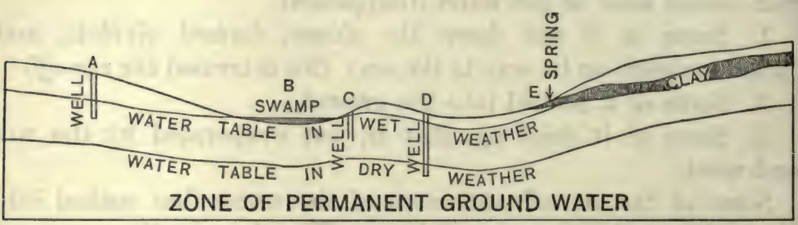


FIG. 63. — Diagram showing the relation of the water table to wells, to a swamp, and to a spring.

of the shallow wells but not below the bottoms of the deep ones (Fig. 63).

The water table or water surface may be defined as the surface below which the ground is saturated with water; in a perfectly flat plain it may be practically level; under hills it domes upward and under depressions it bends downward, but its surface is more even than the surface of the ground above (Fig. 63). In arid regions the conditions are somewhat different.

Movement of the Ground Water.—On account of the constant pull of gravity the water tends to seep downward into the earth as far as it can, and also to move sideward from higher toward lower land (Fig. 67). In this movement some of the water creeps out of the hillsides and gets into the streams. If, in its downward movement through porous soil or rocks, the water reaches a layer of clay or shale or some other substance into which it cannot soak, it slowly creeps along on top of this impervious layer

in the direction of its slope, and may somewhere come to the surface as a spring (Fig. 65). Some of it oozes out in low places, forming swamps; some finds its way into surface streams, and some may even continue on its underground journey until it comes to the sea.

Upward Movement. — When the surface of the ground be-

Fig. 64. — Cracks in limestone filled with calcite deposited by underground water. (*U. S. Geol. Sur.*)

comes somewhat dry, it acts like an ink blotter or sponge and absorbs moisture from the wet layer next below, causing an *upward movement* of the ground water. This is of great importance to growing plants and to crops in dry weather, for they would die for want of moisture if they were not thus nourished. Some plants, such as alfalfa and clover, have the ability to send their roots far down into the ground in search of water.

Certain plants are called *drought-resisting* because they can live in times of prolonged dry weather when most plants perish. Drought-resisting crops are being grown more and more in the semiarid lands of the West.

How Upward-moving Ground Water Benefits or Injures the Soil. — In clear weather the sun and wind are constantly evaporating moisture from the soil. In dry climates the evaporation is excessive, and the ground water, ever moving upward and evaporating, slowly deposits in the top soil the dissolved solids which it contained. Sometimes these solids, or salts, add fertility to the soil. In other cases they may belong to the class of salts called *alkalis*, which are injurious and even destructive to vegetation; these soon ruin the soil. This explains why some desert soils are extremely productive when irrigated, while others would be of little or no use if they were irrigated. In the arid states like Nevada and Utah both of these types of soil occur.

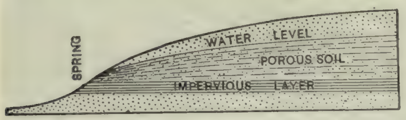


FIG. 65. — Diagram showing how an impervious layer of earth or rock may cause a spring on a hillside.

Wells. — If a well is drilled or dug deep enough into the earth, it will penetrate ground water and be constantly supplied. Many deep wells that supply cities are pumped almost constantly day and night and yet always contain water.

Artesian Wells. — In many places artesian wells have been drilled to depths of hundreds and even thousands of feet.[1] In southern New Jersey, Delaware, and Maryland, in southern Wisconsin and northern Illinois, in the Dakotas, and in several other states, artesian wells are numerous and their pure, clear water is a boon to the people (Fig. 66). In one region in South Dakota there are over 1000 flowing wells, some of them yielding from 1000 to 2000 gallons a minute. Because of their porosity, sandstones are the principal sources of artesian water.

[1] Originally the term "artesian" was applied only to flowing wells, but it is now applied also to very deep, drilled wells, even though the water has to be pumped from them.

FIG. 66. — A flowing artesian well. (*U. S. Geol. Sur.*)

Economic Value of Wells. — Pure drinking water, like pure air and food, is absolutely essential. Streams and lakes are often impure, particularly in thickly settled regions, for all kinds of impurities are washed into them. The water of shallow wells and open wells often contains disease germs, but water which has filtered a long distance through the subsoil and porous rocks is thereby freed from harmful impurities (Fig. 67). Therefore, deep, drilled wells are to be preferred as sources of drinking water. The wells of a state have a value reaching into millions of dollars. While many cities obtain their water from lakes and rivers, it is estimated that a majority of the people of the United States depend for drinking water directly upon underground supplies. In villages and on farms nearly every family has a well, and a farm or village home without a well or spring may be valued at several hundred dollars less than it would be if it had good drinking water. In prosperous farming regions almost every farm has a windmill or gasoline engine used to pump well water for the family and the stock.

Irrigation from Wells. — There are deep artesian wells in the oases of the Sahara used in part for irrigation. Half the irriga-

tion of southern California is said to be done with underground water. In India, where a great deal of the cultivated land is irrigated, nearly as much of the water is supplied by wells as by canals.

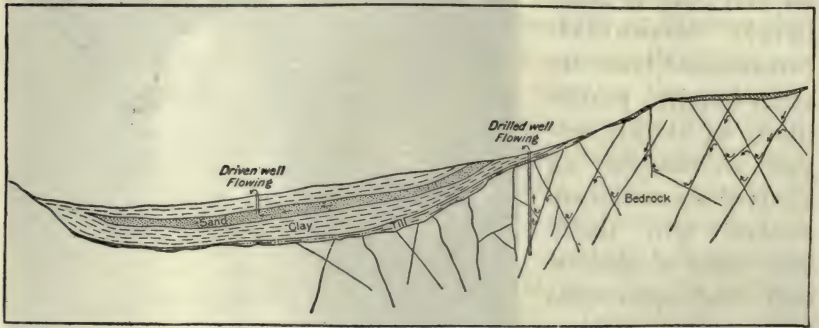


Fig. 67. — Two conditions under which flowing wells may occur. Note the movement of the ground water in the cracks of the rock as indicated by the small arrows. (*U. S. Water Supply Paper 374.*)

Fig. 68. — Mouth of Mountain Geyser, Yellowstone National Park. The incrustations around the opening are mineral deposits formed by the hot waters. (*U. S. Geol. Sur.*)

Mineral Waters. — As ground water seeps through the soil and rocks, it dissolves small amounts of mineral matter. In limestone regions, the water is "hard," due to the dissolved lime which it contains. Some waters contain enough iron to make it noticeable to the taste. Sulphur waters have the disagreeable odor of bad eggs. In somewhat rare cases the waters of springs contain quite a quantity of dissolved salts which have medici-

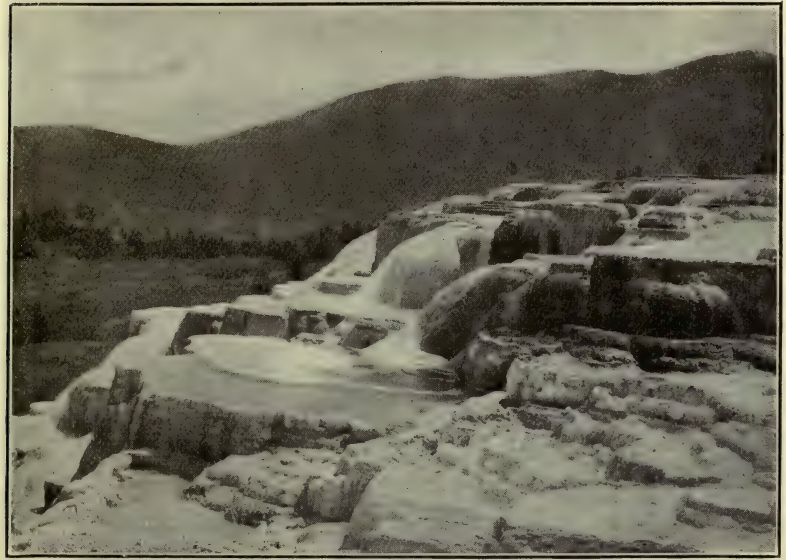


Fig. 69. — Terraces formed by the mineral deposits from the Mammoth Hot Springs in Yellowstone Park. (*U. S. Geol. Sur.*)

nal value; such springs lead to the establishment of sanitariums, hospitals, and watering places, as, for example, at Saratoga Springs, New York. Large quantities of real and so-called mineral waters are bottled and sold, — seven or eight million dollars' worth in the United States yearly.

Hot Springs. — Springs of hot water occasionally occur, as in Virginia, Arkansas, and notably in the Yellowstone National Park (Fig. 69). Such waters are believed to rise from consider-

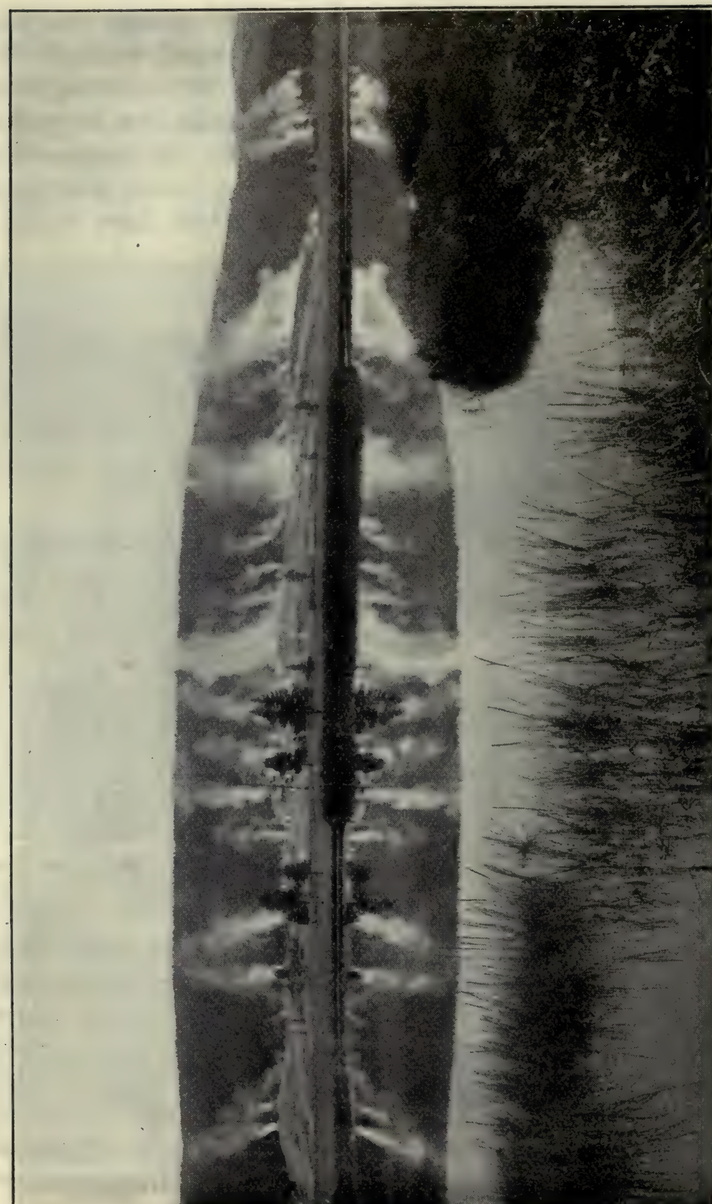


FIG. 70. — Beehive group of geysers near Fire Hole River, Yellowstone Park. (*U. S. Geol. Sur.*)

able depths — thousands of feet — where they have been in contact with heated rocks, due possibly to intrusions of lava. In some instances beautiful formations are built around the mouths of the springs as the water cools and deposits its dissolved mineral matter (Fig. 68). Few sights in nature are more beautiful

Fig. 71. — Geyser in eruption, Yellowstone Park. (*U. S. Geol. Sur.*)

than the terraces formed by the hot springs of Yellowstone Park (Fig. 69).

Geysers. — In New Zealand, Iceland, and Yellowstone Park there are hot springs of an unusual type, known as *geysers*. Old Faithful (in Yellowstone Park) is an excellent example. About every 55 minutes, the water in the crater at the mouth of the geyser tube begins to boil violently, deep rumbling sounds are heard in the earth around, and shortly a huge fountain of hot water and steam is hurled high into the air; this continues for several minutes, then subsides. The performance is repeated

with clocklike regularity hour after hour. There are about 100 geysers in this park, some spouting every few minutes, some at irregular intervals of hours or days. Besides the geysers there are some 3000 hot springs in the park. As you walk about in the geyser basins you hear the rumbling of boiling waters under you, and see jets of steam issuing from crevices all around (Fig. 70).

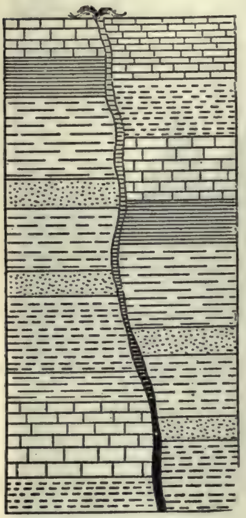


FIG. 72. — A fissure in the rocks (along a fault plane) being filled with mineral matter by upward-moving hot water. The fissure, when filled, becomes a mineral vein.

Cause of Geysers. — It is believed that the heat is supplied by beds of lava which are gradually cooling below the surface of the earth. In favorable places irregular, tubelike openings exist in the rocks, down which the surface waters work their way and reach the heated rocks below. This column of water, possibly extending downward thousands of feet, forms a great weight upon the water near the bottom of the tube and the pressure keeps it from boiling until an extremely high temperature is reached. Hotter and hotter becomes the water near the bottom of the tube, which is held down by the weight of the water above. Finally it becomes so hot that it can no longer be confined and it bursts into steam with explosive violence and drives the water in the tube up and out in the form of a geyser (Fig. 71). Part of the same water flows back into the tube and the process is repeated again and again.

The Work of Ground Water in Forming Mineral Veins and Ore Bodies. — On page 43 is a statement explaining the way in which gold-bearing veins and others of similar origin are formed; there is quite general agreement that the agents which accomplish the work are circulating waters and vapors in the earth which, in their movement through the rocks, collect particles of metal and deposit them later in the fissures and openings of the

rocks (Fig. 72). Were it not for the work of ground water in thus bringing together the minute grains of metal, widely scattered through the rocks, and concentrating enough metal in one place to make it profitable to mine, man would have few if any

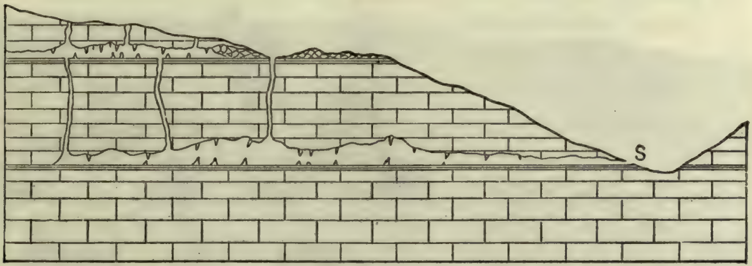


FIG. 73. — Diagram showing how surface waters work their way downward in limestone rocks and produce caves by solution and erosion.

metals to use, and without the metals he would probably still be a savage. The formation of iron ore beds is discussed on page 37.

How the Ground Water Helps to Make and Destroy the Rocks. It is evident from preceding explanations that (1) both hot and cold waters are moving through the rocks, upward, downward, and sideward; and (2) that these waters dissolve mineral matter in some places and deposit it in others. By the dissolving of parts of the rocks they are weakened and their destruction is hastened (Fig. 73). Where the ground water is depositing mineral matter, pores, cracks, and fissures are being filled, and the rock is thus more firmly cemented together.

Petrifaction. — In Arizona, in Yellowstone Park, and in some other regions are found petrified trees which have been or still are encased in the rocks (Fig. 74). So perfect is the reproduction that there is no doubt they were once living trees. It is believed that the logs were long ago buried in sediments or volcanic material, and that during past ages underground waters, charged with quartz, slowly carried away the wood and, particle by particle, replaced it with mineral matter until all the wood had been removed and in its place quartz in many beautiful col-

ors had been deposited; but the exact form and structure of the log is preserved with all of its rings, bark, knots, etc. The Petrified Forests of Arizona are among the interesting phenomena of

FIG. 74. — Petrified logs near Adamana, Arizona. (*U. S. Geol. Sur.*)

the Southwest. Not only wood but shells, corals, bones, etc., may be replaced by the process of petrifaction.

The Cause of Caves and Caverns. — A traveler in parts of central Kentucky rarely sees a surface stream, possibly only one in 20 miles or more, but saucerlike depressions called *sink-holes* are seen everywhere. Most of the rainfall of such a region does not run off, but disappears into the ground, usually by way of the sink-holes. The underlying rocks are limestone and are somewhat soluble in the water, which seeps through the cracks, fissures, and other openings, gradually enlarging them into passages

and caverns. It is estimated that the combined length of such caverns and passages in central Kentucky reaches thousands of miles (Fig. 75).

Noted Caverns. — The most famous of these is the Mammoth Cave in Kentucky. Here the underground waters, working for ages, have carved out domes, rotundas, corridors, and every variety of passage, reaching on and on, up and down, in and out, almost endlessly. In fact many of the passages have never been

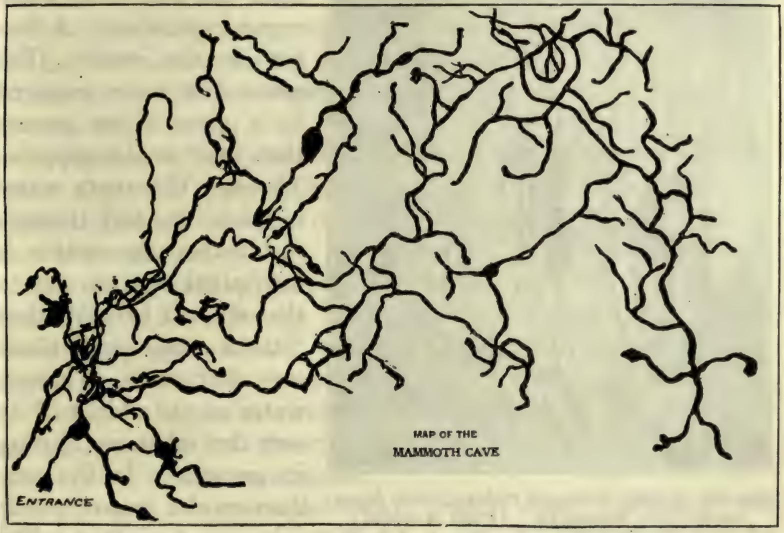


Fig. 75. — Map of a part of the passages in Mammoth Cave, Kentucky. (*After Hovey and Call.*)

explored. The Great Dome in the Mammoth Cave is 400 feet long, 150 feet wide, and from 80 to 150 feet high. Only in the lowest passages do the underground streams flow, finally uniting and emerging as the Green River. Southern Indiana and western Virginia also have famous caverns. The Luray Caverns of Virginia are famed for the rare delicacy and opalescent beauty of their stalactites and stalagmites (Fig. 76). *Stalactites,* like icicles, hang from the roof of the cavern; they are slowly built

downward by dripping water containing dissolved limestone or calcite. On the floor of the cavern the dripping matter builds up columns of similar material called *stalagmites*. Frequently the two unite and form a pillar.

Dependence of Man's Food Supply upon the Ground Water. — This is the most vitally important topic discussed in this chapter. Practically all vegetation lives by taking water from the soil. No water — no vegetation! A desert is the result. The amount of water required by a plant is far greater than one would suppose. Through the roots water is taken up, and through the leaves the water is transpired or given out to the air. It is said that "the average crop plant uses 450 times as much water as the weight of its own dry substance, during its growth." In the production of a crop of wheat or corn something like 4000 or 5000 pounds of water are directly and indirectly used for each pound of grain produced. A pound of meat is estimated to represent the use of ten times as much water as a pound of grain. If this is true, then a loaf of bread and a pound of steak have together required the services of 22 tons of water. It is estimated that each person requires the services of 6800 tons of water annually to produce his food. In the great irrigation projects in the West the government engineers plan to supply the irrigated lands with about 6800 tons of water a year for each inhabitant.

Fig. 76. — Stalactites and stalagmites in Mammoth Cave, Kentucky. (*Field Museum.*)

Thus it is seen that the number of people who can be fed from a given area of tillable land depends upon the amount of available ground water. Basing his calculations upon the amount of available ground water, McGee estimated that the United States is capable of producing food for 1,000,000,000 people.

Summary

The pores and open spaces in the soil and rocks down to a depth of about 20 miles contain a vast amount of water; this is estimated at enough to make a layer 1000 feet deep over the entire *land surface* of the earth.

In regions of heavy rainfall the ground may be saturated with water almost or quite up to the surface, while in dry regions the water table may lie scores or even hundreds of feet below the surface of the ground.

Due to the pull of gravity this water seeps through soil and rocks toward lower levels. In dry weather it moves upward into the dry top layers of soil, which absorb it much like a blotter or sponge, and it evaporates at the surface or is taken up by plants.

Much of the ground water works its way out in the form of springs, or seeps into the streams, or comes to the surface in low places, thus producing swamps.

Wells reach down into the zone of ground water. Artesian wells are, as a rule, deep, and if drilled in relatively low ground, may be flowing wells. The value of well water is very great; it is estimated that a majority of the people of the United States depend upon wells for drinking water. In some parts of the world, India and California for example, irrigation by well water is common.

Some ground waters contain minerals of medicinal value. Hot springs and geysers occur where ground water comes in contact with heated rock at considerable depths in the earth. Geysers are rare; the principal geyser regions being in Yellowstone Park, Iceland, and New Zealand. The first named has about one hundred.

Heated ground waters and vapors moving through the rocks collect metallic substances, like gold or silver, and afterward deposit them in veins and ore bodies.

Sand, clay, and gravel are cemented into rock by natural cements carried by ground water. In other places, the cementing material may be dissolved away and the rock caused to crumble.

Under special conditions, the wood of buried trees is replaced by mineral matter which reproduces perfectly the texture of the wood — a process called *petrifaction*. The petrified forests of Arizona supply exquisitely beautiful specimens.

In many limestone regions underground waters have dissolved and eroded caverns, sometimes of great size, as in the case of Mammoth Cave of Kentucky.

The most important service of ground water is its work of nourishing plants which provide food for the people; 4000 to 5000 pounds of water are necessary for the production of every pound of corn or wheat, and it is estimated that six or seven thousand tons of water a year are directly or indirectly required to produce the food for each person.

EXERCISE IX

Problems

1. How are the proportions of the rain water which (1) run off, (2) soak in, and (3) evaporate, affected by each of the following conditions?

(*a*) Steepness of the slope of the land

(*b*) Rapidity with which the rain falls

(*c*) The character of the surface, whether bare ground, grass land, or forest

(*d*) The character of the soil, whether mostly sand or mostly clay

(*e*) The climate, whether moist, dry, hot, or cool

2. The ocean covers about three-fourths of the earth's surface and has an average depth of about 13,000 feet. How many times as much water is in the oceans as the estimated amount in the ground? (See page 91.)

3. Some wells may be pumped continuously for hours or even days without any apparent diminution of the water supply. How do you account for this?

4. The water from deep wells is less likely to contain *harmful* impurities than that from shallow wells; does it follow that the former is necessarily *purer* than the latter? Explain.

5. Water from some springs has the same temperature summer and winter. Account for this. (Consider depth of source of supply.)

6. Deposits of copper, gold, silver, and some other metals are, as a rule, found in regions that show evidences of past volcanic activity. Is there any reason for this? Explain.

7. Caves or caverns are nearly all found in limestone rocks. Why is this?

8. Mr. A lives in a valley; the surface of the water in his well is about 40 feet below the surface of the ground where his well is located. Mr. B lives on ground 100 feet higher and desires to drill a well there. Will he necessarily have to drill 140 feet to get water? Explain.

9. How is the water of geysers supposed to be heated? Would you expect to find geysers in the Appalachian Mountains? Why or why not?

10. Make a list of the different ways in which man derives benefit from the ground water. Select the three most important of these. Give your reasons.

CHAPTER VII

RIVERS AT WORK

Why There Are Rivers. — Streams are nature's means of carrying off surplus rainfall. A part of the water which falls as rain flows along little depressions in the land and unites with other streamlets, which finally grow into creeks and rivers. Freely running water follows lines of least resistance, and under the attraction of gravity winds its way ever toward lower land. Some of the stream water soaks into the ground, and some of the ground water seeps into the streams and feeds them long after the rain has ceased. If the rainfall is slight, there may be no *permanent* streams. *Rivers are the result of rainfall, slopes, and gravity.*

Recall from your former study of geography the meaning of: (1) river system, (2) river basin, (3) watershed or divide, (4) mouth, (5) source.

The River's Primary Work and Its Incidental Work. — While the river's primary work is that of carrying off surplus water (*drainage*), its incidental work of *erosion* is scarcely less important. As a stream flows along its winding course, the water cuts into the banks and scours the bed of its channel. Formerly people did not understand that rivers make the valleys in which they flow. They thought of valleys merely as depressions in the land into which water would naturally drain, and in which rivers would naturally flow. We have now come to understand that, as a rule, valleys are made by the streams themselves.

Erosion

How Streams Erode. — After a heavy rain the streams are muddy, and if a pailful of this muddy water is allowed to stand,

a layer of sand and later a film of clay settle on the bottom. Some of this sediment in the stream was washed from the land, and some was eroded from the banks, particularly at the curves. In spring the melting snow in the mountains may convert these streams into torrents that are able to roll along heavy stones (Fig. 77). Such streams erode or dislodge an enormous quantity of rock material which furnishes the tools for further scour-

FIG. 77. — Course of a mountain stream, showing the large size of the stones which are moved by a rapid current. (*U. S. Geol. Sur.*)

ing of the channel. Thus, by undercutting their banks, plucking loose rocks, and grinding them up into eroding tools, the rivers deepen and broaden their channels; the greater part of this work is done when the streams are at flood.

How Weathering Aids Erosion. — By weakening the rocks, the weathering agents (see page 55) make the work of stream erosion much easier than it otherwise would be. Some of the rock waste produced by weathering is washed into the streams, or

FIG. 78. — A mountain slope deeply gullied by small streams that flow only at times of rain. On such steep, bare slopes, erosion is very effective. (*U. S. Geol. Sur.*)

slides and creeps down to the water's edge and is swept away with the next flood, only to have the process repeated again and again.

How Valleys Are Made Deeper and Wider. — Under some conditions, as in the case of the Grand Cañon of the Colorado, for example, the river erodes its channel to a great depth, but the gorge does not become very broad, owing to its relative youth and

FIG. 79. — A meandering stream, California. (*U. S. Geol. Sur.*)

to the slowness of weathering in a dry climate. In other places, active weathering causes the valley to broaden as rapidly as the stream deepens it, and a wide, open valley is made. Furthermore, rivers commonly flow in curves, cutting first against one side of the valley and then against the other. This *lateral* or *sideward erosion* is one of the principal ways by which streams broaden their valleys (Fig. 79). Briefly stated, valleys are deepened by *vertical* or downward erosion and are widened by weathering, surface washing, and the swinging of the stream from side to side.

The great ox-bow curves made by rivers are termed *meanders* (Fig. 96). In a later chapter it will be shown how glaciers also widen and deepen valleys.

The rate at which rivers erode depends mainly upon (1) the hardness of the material (rock or earth) in which the river is working; (2) the rapidity with which the river flows; (3) the volume of wa-

FIG. 80. — A young stream whose ungraded course is filled with falls and rapids. (*U. S. Geol. Sur.*)

ter which it carries; and (4) the aid which it receives from weathering. Although we speak of a stream as eroding *rapidly*, we mean this only in a comparative sense, for the great valleys of the world have surely been hundreds of thousands of years in the making; as a rule only minor changes are produced in a man's lifetime.

Young, Mature, and Old Rivers. — A river has its beginning, its period of youth, merging into middle age or maturity, and its old age.

Youth. — In the diagram (Fig. 81a) is represented a plain recently raised above the sea; it is a new land surface and a few streams are just beginning to develop in the slight depressions. These streams are in the stage of early youth, for they have few

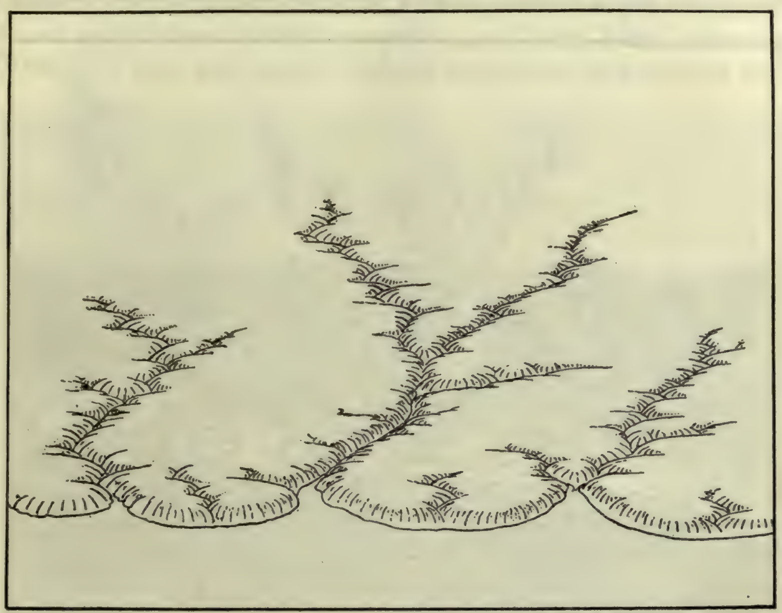


Fig. 81a. — A young drainage system on a plain; few streams, narrow valleys, and wide inter-stream areas. (*Lobeck.*)

tributaries and are separated by broad stretches of land which are poorly drained.

Maturity. — Gradually the main streams deepen and widen their valleys, more tributaries develop, and the whole region slowly becomes one of many branching valleys between which rise hills — the remnants of the upland in which the valleys are being cut. The river system has passed into the stage of maturity, but a long period of time has elapsed in bringing it to this stage (Fig. 81b).

Old Age. — If the work of weathering and erosion (together termed *denudation*) continue, the hills will become still lower, the slopes more gentle, the valleys wider, and eventually old age will be reached. Such uninterrupted progress from early youth to old age rarely occurs, because the time required to accomplish

Fig. 81b. — The same region as that in Fig. 81a, but showing the streams in a more advanced stage of development; many streams, broader valleys, and narrower inter-stream areas. (*Lobeck.*)

it is so long that an uplift or a sinking of the land is almost sure to intervene before old age is attained.

The Same River May Have Young, Mature, and Old Portions. — Many rivers in their lower courses have the qualities of advanced age; in their middle courses they have the steep valley slopes and occasional rapids which belong to the stage of early maturity; and in their headwaters in the mountains they have all the traits of turbulent youth; that is, vigorous erosion, steep-

sided gorges, many rapids and falls, and bowlder-filled channels.

Impressive Features of River Work

Rapids and Falls. — These belong to the period of the river's youth. *Rapids* are stretches in a river where the water plunges down rocky ledges or over accumulations of loose rocks, churning itself into foam and usually making navigation dangerous or im-

Fig. 82. — Falls in the Missouri River in Montana, due to a resistant bed of rock in the channel of the river. (*U. S. Geol. Sur.*)

possible. The Whirlpool Rapids in the Niagara River and the rapids of the St. Lawrence are examples on a grand scale. In the process of time, however, the plunging water tends to wear away the rocks that cause the rapids, and the rapids disappear.

Falls are due to a variety of causes, the most common one being the presence in the river's course of rocks of unequal hardness or resistance. The beautiful Lower Falls of the Yellowstone, in the Yellowstone National Park, are due to a body of resistant, igneous rock which here extends across the river (Fig. 83).

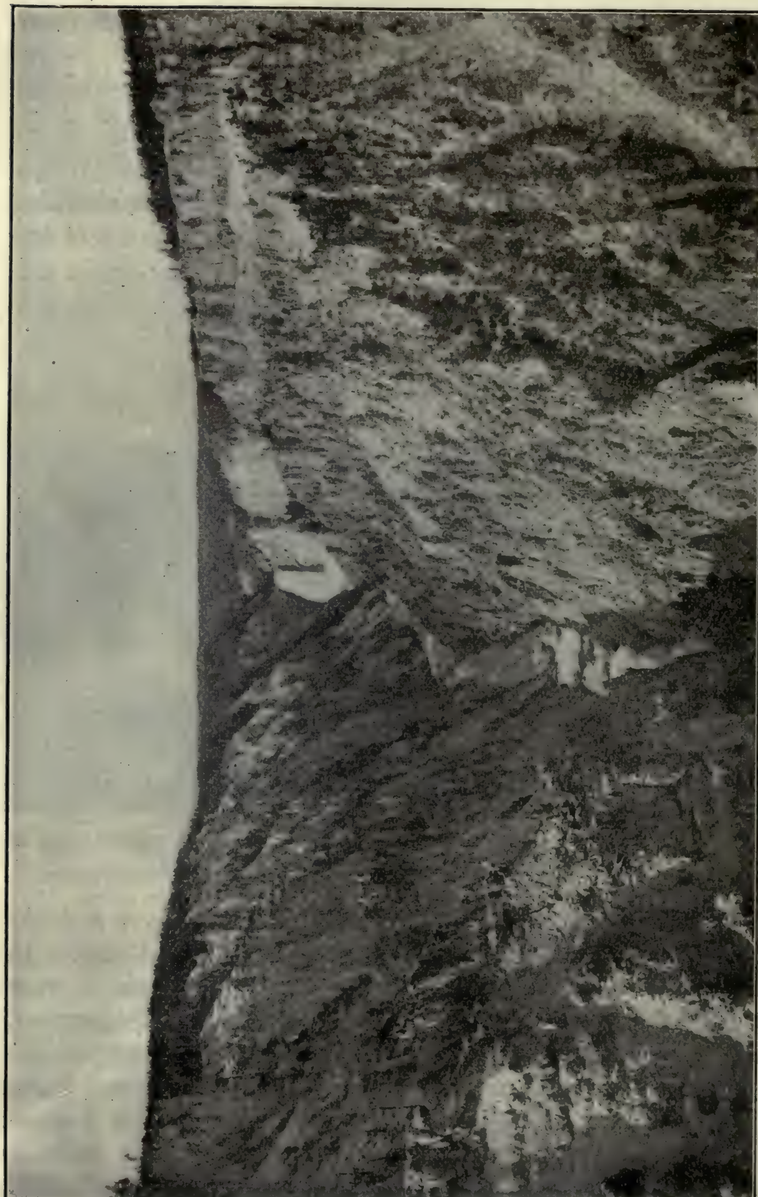


Fig. 83. — Great Falls and cañon of the Yellowstone River. The rocks on either side of the cañon are of a rich yellow color, giving the river its name. (*U. S. Geol. Sur.*)

Niagara Falls are due to a thick layer of limestone which is underlain by softer layers of shale (Fig. 84). Near the end of the Glacial Period the Niagara River was born; it flowed northward as now, and about seven miles below the present falls it plunged over the edge of the Niagara limestone, which there forms

FIG. 84. — The American Falls at Niagara. (*U. S. Geol. Sur.*)

an escarpment, or steep rock-slope. The limestone is resistant, but the swirling water at the base of the fall gradually undercuts the softer shales below, and the heavy limestone, robbed of its support, breaks off in huge blocks and tumbles into the chasm. Each time this occurs the crest of the cataract recedes a few feet farther upstream. Century by century the fall has worked its

way upstream, leaving a deep gorge, now over seven miles in length, extending downstream from the falls.

Future of Niagara Falls. — At the present time the cataract is divided into two parts by Goat Island (Fig. 84). The lesser fall is on the American side of this island and the great horseshoe fall is on the Canadian side. So much more water pours over the latter that its crest is receding faster than that of the American fall; in the course of time it will probably draw to itself

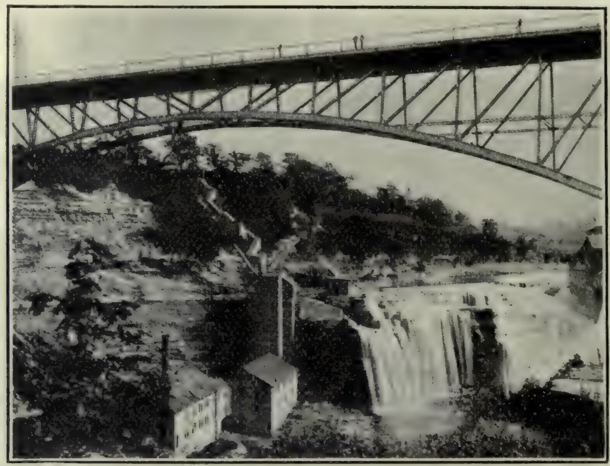


FIG. 85. — A view of the Lower Falls of the Genesee River at Rochester, N. Y., as they appeared years ago. The city owes much of its early growth to the water power available at the falls. (*Physiography Lab. Cornell Univ.*)

more and more of the volume of the river, and gradually the American fall will dwindle away and Niagara will again be a single cataract.

Niagara as a Measure of Time. — Knowing that Niagara Falls came into existence near the end of the Ice Age, and having noted that its crest *now* recedes at the rate of about 5 feet a year, geologists have sought to use these facts as a means of estimating the length of time since the Glacial Period. If we were sure that the falls had always receded *at the same rate as now*, we should have only to divide the total number of feet that the falls have

retreated (7 miles = 36,960 feet) by the number of feet of retreat each year (say 5) and we should get about 7400 years. But since we know that the retreat of the falls has not always been at the present rate, this period of 7400 years can be considered only as an interesting but inaccurate measure; 20,000 to 35,000 years is accepted by many as a more probable estimate.

Other Noted Falls.— The *Falls of St. Anthony* in the Mississippi River, locating the great flour-milling city of Minneapolis, and similar *Falls of the Genesee River* in New York, locating Rochester (Fig. 85), once the leading flour-milling city, are of the same general type as Niagara; while the *Falls of the Passaic River*, locating the silk-making city of Paterson, N. J., are due to a body of igneous rock extending across the river's course. In their formation they resemble the Lower Falls of the Yellowstone, referred to on page 115.

The *Victoria Falls* of the Zambesi River in South Africa, said to be more imposing than Niagara, are due to inequalities in a vast body of solidified lava in which the river is cutting this portion of its channel. The *Shoshone Falls* in the Snake River in Idaho are of somewhat similar origin.

Summarizing, we may say that rapids and falls belong to the youthful stage of a river, are usually due to the presence of unequally resistant rocks in the stream channel, are often of imposing grandeur, frequently afford water power of great value, but in time disappear by erosion.

The Grand Cañon of the Colorado. — Speaking of this chasm, a noted geologist has said: "Of all the gorges and cañons of the world, and perhaps of all works of nature, the most wonderful example is the Grand Cañon of the Colorado" (Fig. 86). Dutton, to whom we owe many masterly word pictures of western scenery, wrote: "It is not magnitude alone that gives this marvelous cañon its preëminence; it is the gorgeous and varied coloring of its mighty walls, the endless details in the sculpturing of its battlements and towers, the ever changing atmospheric effects of its profound depths and the wonderful stimulus to the imagination with which it feeds the mind."

Rising in the heart of the Rocky Mountains, the Colorado River in its lower course traverses the arid plateaus of the Southwest, and pours its muddy current into the Gulf of California. The river is 2000 miles long, but the Grand Cañon (in Arizona)

is between 200 and 300 miles in length. The Colorado plateau has been slowly rising during the long ages that the river has

FIG. 86. — Portion of the Grand Cañon of the Colorado River in Arizona. The rocks are of many colors; the cañon is nearly a mile deep. (*U. S. Geol. Sur.*)

been eroding the chasm, which is now a mile deep and from 5 to 13 miles broad at the top, yet scarcely wider than the river at the bottom. Tributary gorges, into whose depths the sun pene-

trates scarcely two hours a day, branch out from either side. The nearly horizontal beds of rock, of gorgeous colors, and unequal hardness, weather into castellated forms and complete the most impressive example of river erosion that the world affords. Here we have an instance of river-cutting (1) in an arid plateau, (2) by a stream of large volume and rapid flow, (3) being supplied with abundant cutting tools, and (4) allowed to pursue its work for ages without interruption; the Grand Cañon is the result.

Erosion and Natural Scenery. — Running water has been the master sculptor of the ages. Without its work the surface of the earth would present an aspect of dull monotony, with stretches of featureless plains, and dreary plateaus devoid of scenic beauty. Instead of majestic peaks, we should have only huge swells or blocks of uplifted rock without pass, valley, or cañon; no gorge of the Rhine, no Alpine peaks, no Royal Gorge of the Arkansas, or Iron Gates of the Danube; no gorgeous cañon of the Yellowstone or Colorado; no Delaware Water Gap, or Niagara. It is the work of weathering and erosion that gives us the endless variety of mountain sculpturing, and much of the charm of all natural scenery.

Transportation and Deposition by Rivers

Material Carried in Suspension. — In quiet water, even fine particles of clay soon sink, but in rapidly flowing water, sand and gravel are carried, and large stones are rolled or shoved along (Fig. 77). A stream's power of carrying rock waste is greatly increased by even a moderate rise in velocity.

Importance of Velocity. — A river flowing less than one mile an hour (a third as fast as a man walks) can carry large grains of sand, while one flowing twice as fast can carry stones 64 times as heavy. The law is: *the transporting power of a river varies as the sixth power of its velocity;* that is, by multiplying the velocity of the current by two, for example, the carrying power is multiplied by the sixth power of 2, or 64. Swift mountain streams,

and rivers at flood, roll along bowlders weighing hundreds of pounds.

Illustrations of the Quantity of Material Carried by Rivers. — The Mississippi annually carries to the Gulf of Mexico upwards of 400,000,000 tons of sediment. This is more material than was excavated in digging the Panama Canal. At its flood stage the Colorado pours silt into the Gulf of California at the rate of 1000 tons a minute. It is estimated that if all the streams of the United States could have been concentrated on the Isthmus of Panama they would, in 73 days, have dug the canal, which required ten years to complete with the most powerful machines devised by man.

The Po River in northern Italy is removing rock waste at a rate that is equal to lowering the entire surface of its basin one foot every 729 years. The rivers of the world carry a greater weight of sediment to the sea every year than the weight of all the freight carried by all the railroads in the same length of time.

Material Carried in Solution. — Besides the *visible load* which rivers carry in suspension, they also carry an *invisible load* of dissolved material taken from the soil and rocks through which the water has passed; most of the common salt and lime carbonate in the ocean was carried there in this way. Even as small a body of water as Great Salt Lake in Utah contains as much salt as the 100,000,000 American people use in 90 years at the present rate of consumption. It has been estimated that streams annually carry 100 tons of dissolved matter *on an average* for every square mile of land surface of the earth, or about 5,000,000,000 tons — 3,000,000 train loads.

Floods. — There could be no rich alluvial plains without floods, but these floods are often disastrous. The flood in Ohio in March, 1913, which did such damage to the city of Dayton, destroyed about $200,000,000 worth of property (Fig. 87). The Johnstown flood in Pennsylvania (1889) drowned over 2000 people. The Hwang, or Yellow, River is known as "China's Sorrow" because of the appalling loss of life due to its frequent floods. Its flood plain is one of the most densely populated regions of

the world, and time after time from half a million to a million people have lost their lives by the river's overflow. The frequent and devastating floods of the lower Mississippi are matters of

FIG. 87. — A street in Dayton at the time of the flood of 1913.

national concern, and their control offers one of our great engineering problems.

Deposits Made by Rivers. — It necessarily follows that, since rivers erode the land and transport the waste, they must deposit it somewhere. Wherever the velocity of a stream is checked, its transporting power is reduced, and sediment is likely to be deposited.

Sand bars are built on the inner side of the curves of a river or along level stretches, or wherever the velocity of the stream is checked.

Flood Plains. — When streams overflow their banks and inundate the bordering lowlands, they deposit a layer of silt or sand and gradually build up the *flood plains* or alluvial plains which border many rivers, especially in their lower courses. Many of

the richest agricultural valleys in the world are the flood plains of great rivers like the Nile, the Ganges, and the Yangtze, which were the seats of great nations and high civilizations as far back as history reaches.

Deltas. — Some rivers, but not all, enter the sea or lakes under such conditions that their sediments are deposited at the mouth and build up *deltas.* A few rivers, like the St. Lawrence, flow through lakes in which they deposit most of their load and so have little material with which to build deltas; the mouths of

Fig. 88. — Alluvial fans resulting from placer mining operations, Montana. (*Physiography Lab. Cornell Univ.*)

other rivers are so swept by tides and currents that deltas do not form.

The delta of the Nile is a triangle 120 miles on each side and is intensively cultivated (Fig. 125). A large part of Holland is the delta of the Rhine (Fig. 115). The head of the ancient delta of the Mississippi is at Cairo, Ill., 600 miles from the present mouth. The delta of the Hwang River in China is more than 600 miles broad, and is the home of many millions of people. The rich valley of the Po, in northern Italy, is built of delta and flood-plain deposits. The Rhone is advancing its delta into the Mediterranean at the rate of a mile a century.

Alluvial Fans. — At the mouths of mountain valleys, especially in arid lands, rivers, fed by mountain rains and snows, plunge down the steep slopes carrying loads of rock waste. At the base of the mountains their speed is checked; they flow some distance out into the plain or desert, then gradually sink into the sand, and the rock waste which they deposit builds alluvial fans (Fig. 88), often many square miles in extent. Sometimes the various fans spread out until they unite and form a nearly continuous slope extending for miles along the base of a mountain range.

FIG. 89. — California and its Great Valley deeply filled with waste eroded from the inclosing mountains. (*Model by Drake, Stanford University.*)

Filled Valleys. — In this way valleys become partially filled and are known as *filled valleys*. The Great Valley of California, extending nearly the length of the state, and the Ganges Valley of India are of this type (Fig. 89).

River Terraces. — Sometimes a river which has partially filled its valley with alluvial deposits has its supply of sediment greatly reduced, and it proceeds to erode a channel in this alluvial filling. As the river cuts its new channel downward, it changes its course more or less, leaving along the sides of the valley portions of the alluvial filling in the form of terraces. This has occurred

in all the rivers which carried away the waters of the melting ice at the close of the Glacial Period; for example, the Connecticut, Delaware, Susquehanna, Ohio, Mississippi, and Missouri.

FIG. 90. — Map showing the location of Quebec, the "Gibraltar of America."

Drowned River Mouths. — Portions of the continents are frequently rising or sinking — very, very slowly, of course. When the land along the coast sinks, the mouths of the rivers are drowned and the sea backs up into the valleys; thus V-shaped bays, widening in the direction of the sea, are formed. Such broad-mouthed rivers are called *estuaries* (Figs. 90, 226, 240). The drowning of the coast deepens these river mouths, and natural harbors are formed, as at New York, London, and Philadelphia. The eastern coast of North America, the coast of northwestern Europe, and many other coasts are of this type.

SUMMARY

Streams are nature's means of carrying away the surplus rainfall. Their own motion and the rock waste which they carry, roll, and drag along enable rivers slowly to wear their channels deeper and wider and thus to carve the valleys in which they flow.

Weathering aids river erosion both by weakening the rocks and by supplying rock waste which the river uses as eroding tools.

Rivers and valleys have their youth, maturity, and old age. In youth the streams have few tributaries and usually flow in ungraded courses and steep-sided valleys. With increasing time

more tributaries develop, rapids and falls disappear, divides are eaten away, and valleys broaden out.

Rapids and falls belong to young streams; they are most commonly due to harder or more resistant rocks in the stream channels. A very resistant layer, like the limestone at Niagara, underlain by softer rocks, produces the cataract type of fall. By the working back of the crest, the fall slowly moves upstream, leaving a gorge below the fall, as at Niagara.

A powerful stream working for a long time in a high plateau will carve a very deep cañon; the Grand Cañon of the Colorado in Arizona, nearly a mile deep, is a striking example.

Rivers erode, transport, and deposit. They carry material in suspension and in solution. A big, swift stream can move rocks weighing many hundreds of pounds; and a great river like the Mississippi carries to the sea hundreds of millions of tons of silt each year.

River deposits take the form of sand bars, flood plains, deltas, and, in special cases, alluvial fans.

When a coast sinks, the mouths of the rivers are drowned, and harbors are produced.

EXERCISE X

1. Why are there rivers?
2. Why do they flow downhill?
3. Why do the main rivers flow to the sea?
4. Why does a river system have a trunk stream and tributaries?
5. Why do rivers flow in winding courses?
6. Why do some rivers flow slowly and others rapidly?
7. Why do some rivers, like the Nile and Colorado, have comparatively few tributaries? (Consider the rainfall.)
8. Why is the same stream sometimes clear and sometimes muddy?
9. Why are most valleys in humid lands occupied by streams?
10. Why do most large streams continue to flow even during dry weather?
11. Why do rivers erode their channels?
12. Why do valleys become broader with increasing age?
13. Why is weathering an aid to valley-making?
14. Why does a river erode more actively on the outer side of a curve than on the inner side?
15. Why do rivers do the greater part of their work at flood time?
16. Why do rivers build sand bars in their channels?
17. Why do some rivers build deltas while others do not?

18. Why do rivers build flood plains?

19. Why does a large river usually have a gentle grade in its lower course?

20. Why do most rivers have steeper grades in their upper than in their lower courses?

21. Why are there rapids and falls in rivers?

22. Why are these an indication of river youth?

23. Why do some waterfalls, such as Niagara, gradually work upstream, or recede?

24. Why do such rivers have gorges below the falls, but not necessarily above?

25. Why are the rivers of the Mississippi system longer, as a rule, than those of the Atlantic slope?

26. Why are there more rivers in the eastern half of the United States than in the western half?

27. Why is erosion called the incidental work of a river?

28. Why has the Colorado River been able to erode such a deep gorge as the Grand Cañon?

29. Why is the volume of the St. Lawrence more uniform than that of the Mississippi?

30. Why does the St. Lawrence carry little sediment?

31. Why does the Missouri carry more sediment than the upper Mississippi?

32. Why are alluvial fans especially numerous in an arid region?

33. Why do some rivers, such as the Rio Grande, diminish in volume as they flow through their lower courses?

34. Why do some rivers, such as the Delaware, have estuaries?

35. Why is the Ohio more likely to have dangerous floods than the Missouri?

36. Why does the Mississippi have such a gentle grade from Cairo to the Gulf?

37. Why do nearly all of the rivers of the British Isles have good harbors at their mouths?

38. Why are the floods of the Hwang River so disastrous?

39. Why do most of the people of Egypt live along the Nile?

40. Why are most of the rivers of Russia sluggish?


ARCTIC OCEAN
ARCTIC ARCHIPELAGO
GREENLAND
(To Denmark)
ICELAND
Denmark Strait
BAFFIN BAY
Davis Strait
C. Farewell
C. Chidley
Hudson Strait
North Magnetic Pole
Arctic Circle
HUDSON BAY
James Bay
LABRADOR
(To Newfoundland)
Strait of Belle Isle
NEWFOUNDLAND
St. Johns
C. Race
Gulf of St. Lawrence
Halifax
C. Sable
Boston
C. Cod
New York
Quebec
Montreal
Ottawa
Toronto
Lake Ontario
Buffalo
Lake Huron
Lake Michigan
Detroit
Milwaukee
Lake Superior
Duluth
St. Paul
Minneapolis
Winnipeg
Lake Winnipeg
Nelson R.
CANADA
Edmonton
Lake Athabaska
Great Slave Lake
Great Bear Lake
Mackenzie R.
Dawson
Mt. Logan
Juneau
Coast Range
Prince Rupert
QUEEN CHARLOTTE ISLANDS
VANCOUVER I.
Victoria
Vancouver
C. Flattery
Seattle
Tacoma
Columbia R.
Portland
Mt. Hood
Mt. Rainier
Spokane
Snake R.
ALASKA
Fairbanks
Yukon R.
Mt. McKinley
Seward
Mt. St. Elias
KODIAK I.
Nome
C. Pr. of Wales
Bering Strait
Bering Sea
Pt. Barrow
ASIA
C. Dezhnef
PACIFIC
OCEAN
70°
80°
180°
170°
160°
140°
120°
100°
80°
60°
40°
20°
60°
50°
40°


NORTH AMERICA
POLITICAL MAP
Scale of statute miles
0 100 200 400 600 800 1000
Capitals of Countries ⊙
UNITED STATES
MEXICO
CENTRAL AMERICA
SOUTH AMERICA
GULF OF MEXICO
CARIBBEAN SEA
WEST INDIES
GREATER ANTILLES
OCEAN
ATLANTIC
Tropic of Cancer
San Francisco
Los Angeles
San Diego
Mt. Whitney
Pikes Peak
Denver
El Paso
Dallas
San Antonio
Houston
Galveston
New Orleans
Kansas City
St. Louis
Memphis
Louisville
Cincinnati
Atlanta
Charleston
Savannah
Jacksonville
Norfolk
Baltimore
Washington
Chesapeake Bay
C. Hatteras
BERMUDA ISLANDS (Br.)
BAHAMA ISLANDS (Br.)
Florida Strait
C. Sable
Key West
Havana
CUBA
Yucatan Channel
JAMAICA (Br.)
Kingston
Port au Prince
HAITI
DOMINICAN REPUBLIC
I. OF HAITI
Santo Domingo
San Juan
PORTO RICO (U.S.)
Gulf of California
C. San Lucas
Sierra Madre
Rio Grande
Gulf of Campeche
Mt. Orizaba
Vera Cruz
Mexico
Popocatepetl
Acapulco
Salina Cruz
REVILLAGIGEDO ISLANDS
Belize
BRITISH HONDURAS
FEDERATED REPUBLIC OF CENTRAL AMERICA
Tegucigalpa
Guatemala
San Salvador
NICARAGUA
Managua
COSTA RICA
San José
PANAMA
Panama
Colon
Panama Canal
Mississippi R.
Arkansas R.
Red R.
Colorado
Ohio
120°
110° Longitude West 100° from Greenwich 90°
80°
30°
20°
10°
0°
WILLIAMS ENGRAVING CO., N.Y.

FIG. 90*a*

CHAPTER VIII

HISTORIC AND ECONOMIC ASPECTS OF AMERICAN RIVERS[1]

Importance of Rivers in our Early History

Rivers the Gateways of the Continent.—When Europeans first came to America they found dense and almost pathless forests. The tangled, thorny undergrowth, the fallen trees with their upturned roots and splintered limbs, the treacherous bogs and swamps combined to make exploration of the continent by land a nearly hopeless task. In that exploration the rivers played a part the importance of which we can now only vaguely appreciate. The St. Lawrence, the Hudson, the Delaware, the Potomac, the James, and many lesser streams led the explorers and colonists inland. The French penetrated 1500 miles into North America by way of the St. Lawrence and the Great Lakes before New York or Philadelphia was founded. Dutch settlements early lined the shores of the Hudson and the Mohawk; English settlements extended up the Connecticut and the Delaware, and less than twenty years after the founding of Jamestown, plantations spread along the James for more than a hundred miles. Yet a short distance back from the rivers the land remained almost untouched.

Early Difficulties of Transportation in the United States.—In this age we have no realization of the part which rivers played in the life of the American people up to the Railroad Era (about 1840). Roads for vehicles existed in but few localities before the Revolution, and for many years afterwards. Even between important cities, the stage roads were frequently almost impassable.

[1] For topical outline, see end of chapter. Pupils should be able to locate the rivers mentioned in the chapter.

An account published in 1797 says: "The roads from Philadelphia to Baltimore exhibit, for the greater part of the way, an aspect of savage desolation. Chasms to the depth of six, eight, or ten feet occur at numerous intervals. A stagecoach which left Philadelphia on Feb. 5, 1796, took five days to go to Baltimore" (90 miles). It is said that President John Adams and his wife, driving overland to Washington, D. C., in 1800, could not follow the road and lost their way in the woods between Baltimore and Washington. Thurlow Weed of New York tells of a stage trip, in 1824, from Albany to the western part of New York (about 300 miles) requiring six days and seven nights. The roads were in such horrible condition that the horses could seldom trot, and passengers frequently had to get out and walk, and sometimes had to push the coach. Under such conditions the transporting of farm products, flour, lumber, wood, and heavy merchandise on land was so slow and expensive that it was nearly prohibitive. It cost on an average from twenty to thirty times as much to ship goods a long distance by wagon or pack-animal as by boat. A hundred dollars a ton from Albany to Buffalo, or from Philadelphia to Pittsburgh, was a common charge. Water transportation offered the only remedy for such conditions. An apparently accurate record shows that during four months in the year 1827 there passed down the Susquehanna River past Harrisburg 1631 rafts (mainly lumber and timber) and 1370 arks or flatboats, carrying farm produce, whisky, coal, etc. It is estimated that 300 keel-bottomed boats also passed during the same period. This would make 3300 boats and rafts passing one city in four months.

Rivers and the Fur Trade. — When the white man came to America its northern forests and streams abounded in fur-bearing animals. The furs brought high prices in Europe, and the profits of the fur trade led thousands of hunters to penetrate the forests, where, for the most part, they followed the rivers and lakes. The Indian canoe and the French batteau were almost the sole mode of travel. Says Professor Turner, "So powerful was the combined influence of these far-reaching rivers and the 'hardy, adventurous, lawless, fascinating fur trade' that the scanty population of Canada was irresistibly drawn . . . into the interminable recesses of the continent." To this day there is a vast region in Canada — the domain of the Hudson's Bay Company — where the rivers are almost the only routes of travel, and the canoe practically the only conveyance.

Rivers and Colonial Agriculture. — Not only does the flood plain of a river furnish rich soil, but in the early days the river itself frequently furnished the only means of marketing the

products of the soil. Nearly all the Virginia planters had their own wharves on the rivers, from which they shipped their tobacco and other products directly to Europe, or by way of the smaller streams to convenient exporting points on the main rivers. The prosperity of the southern tidewater plantations was largely dependent upon the numerous rivers of the region. Throughout the colonies agriculture prospered only when carried on within easy reach of navigable waters.

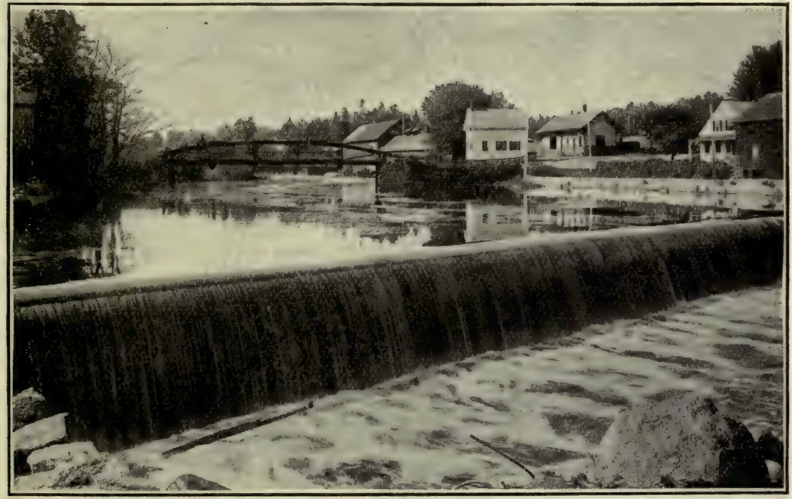


Fig. 91. — One of the hundreds of New England water powers that aided in building up the manufacturing industries of that region. (*Boston and Maine R. R.*)

Rivers and Early Manufacturing. — When the simple home industries began to give way to manufacturing in small mills and factories, streams became important for power. The New England rivers are short and rapid; in fact, most of the Atlantic coast rivers are rapid in some part of their courses. At rapids and falls, sawmills, flour and feed mills, iron forges and furnaces, and later, small cotton and woolen mills, sprang up (Fig. 91). Even as late as 1870, 72 per cent of the manufacturing of New England was done by water power.

The Historic and Economic Importance of the St. Lawrence River System

Early History. — The St. Lawrence with its chain of lakes has become one of the most important inland waterways of the world. It early led the French into the very heart of North America at the time when the English were pushing but a little way up the

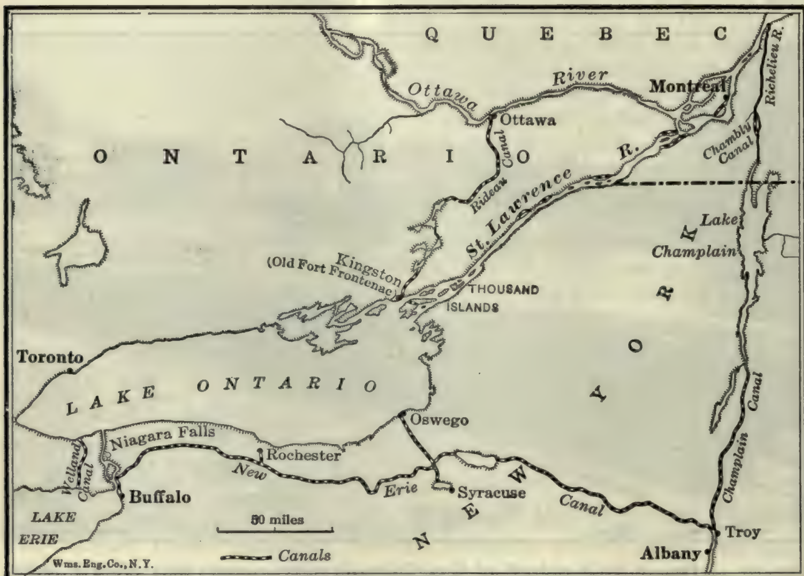


FIG. 92. — Waterways in New York State and the near-by parts of Canada.

short rivers of the Atlantic slope. Explorations of the St. Lawrence and upper Mississippi gave the French kings their claim to the larger part of North America. The control of one strategic point on the St. Lawrence, Quebec, has carried with it the control of a domain half as large as all Europe. Five times in five wars has this stronghold been besieged, and the nation which held Quebec and the St. Lawrence has always held Canada.

Importance to Canadian Commerce.—Montreal, at the head of ocean navigation on the St. Lawrence, is over 500 miles inland, and is Canada's greatest city and seaport. During seven months of the year a major part of the foreign commerce of Canada uses the St. Lawrence River and valley. Steamers drawing 12 feet of

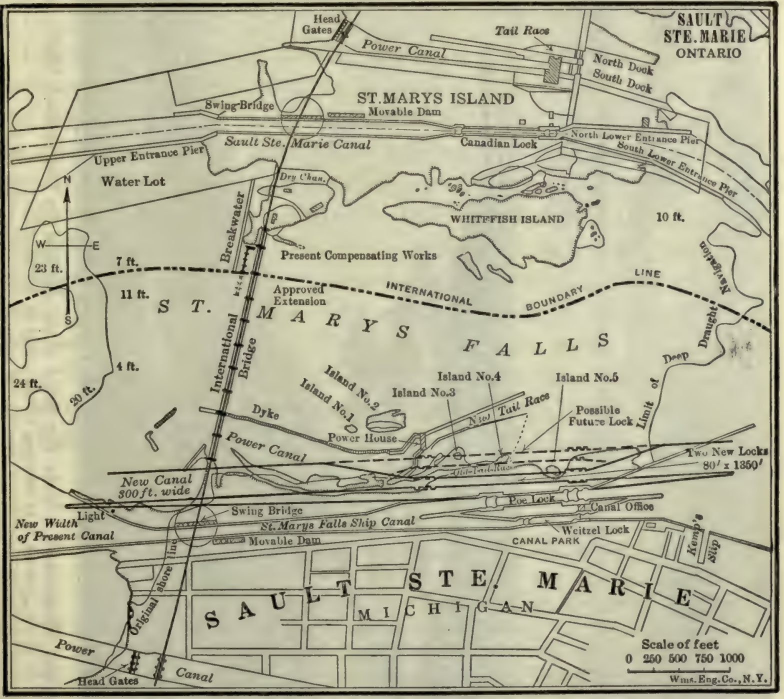


FIG. 93. — Portion of the St. Marys River (the "Soo") which connects Lake Superior with Lake Huron. By means of canals and locks, boats pass around the rapids or "falls."

water may pass from Duluth, at the head of Lake Superior, to the Atlantic Ocean, a distance of 2000 miles. However, canals around rapids and falls are required; there are two American canals and a Canadian canal at Sault Sainte Marie; the Welland Canal[1]

[1] This canal is being enlarged and the number of locks is being reduced.

FIG. 94. — View along the upper Mississippi. Note the flood plain flanked by flat-topped bluffs on either side of the river. (*Courtesy C. M. and S. P. R. R.*)

between Lake Erie and Lake Ontario provides a way around Niagara Falls; and there are six short canals which make navigation possible around the various rapids of the St. Lawrence between Lake Ontario and Montreal. More than half the people of Canada live along this waterway or within two hours' ride of it, and 80 per cent of their manufacturing industries are carried on in the same area.

Physical Features of the River. — In the stretch between Lake Ontario and Quebec the river is from a half mile to a mile wide, but beyond Quebec it opens gradually into a broad estuary and then merges into the Gulf of St. Lawrence. By means of soundings, the old river channel, now deeply submerged by the drowning of the valley, may be traced out to the edge of the continental shelf beyond Newfoundland (Fig. 226). The river is almost free from sediment and is unusually uniform in its flow because of the five Great Lakes in its course. Though it drains an area only one-third as great as does the Mississippi, it carries more water to the sea. The Ottawa River is the only large tributary. Water power is developed at the Soo (Sault Sainte Marie), at points on the St. Lawrence, and on a vaster scale at Niagara Falls (Fig. 93).

The Mississippi — Father of Waters

The lower Mississippi discovered by the Spanish explorer Ferdinand de Soto in 1541 (perhaps by Alonso de Pineda in 1519).

The upper Mississippi discovered and explored by Father Marquette in 1673 (perhaps by the Frenchmen Radisson and Groseilliers in or about 1665).

Length of the Mississippi proper, 2429 miles.

Length from the source of the Missouri to the Gulf, 4200 miles.

Depth at low water, St. Paul to St. Louis, 4 feet.

Depth at low water, St. Louis to New Orleans, 8 to 9 feet.

Navigable depth, New Orleans to Gulf, 30 feet or more.

Average width between La Crosse, Wis., and St. Louis, about 1 mile.

Average width between St. Louis and the mouth of the river, $\frac{1}{2}$ to $1\frac{1}{2}$ miles.

Average slope of the river from St. Paul to Cairo, 6 inches to the mile.

Average slope of the river from Cairo to Gulf, 3 inches to the mile.

Average slope of the river from New Orleans to the Gulf, $\frac{1}{12}$ inch to the mile.

Falls and Rapids:

Above Minneapolis, numerous falls and rapids.
At Minneapolis, — rapids and falls of St. Anthony, total fall of 78 feet.
Near Rock Island, Ill., and Davenport, Iowa, rapids, 20 feet fall in 16 miles.
At Keokuk, Iowa, rapids, 23 feet fall in 12 miles.

The Upper Mississippi. — Most great rivers have their headwaters in mountains, but the Mississippi begins on a plain in a maze of swamps and lakes. From the head of navigation at Minneapolis to the mouth of the Ohio, the river flows through an ancient rock channel filled to a depth of 150 to 200 feet by the river's own deposits (Fig. 94). The ancient channel is in most places several times as wide as the present river and its rocky bluffs rise from 100 to 650 feet above the level of the river. It is a region of rare beauty, scarcely inferior to the Highlands of the Hudson or the Gorge of the Rhine. Its sediments have built countless islands, among which the river threads its way, and the main channel is sometimes hard to determine (Fig. 95). At low water, boats drawing four feet have some difficulty in navigating.

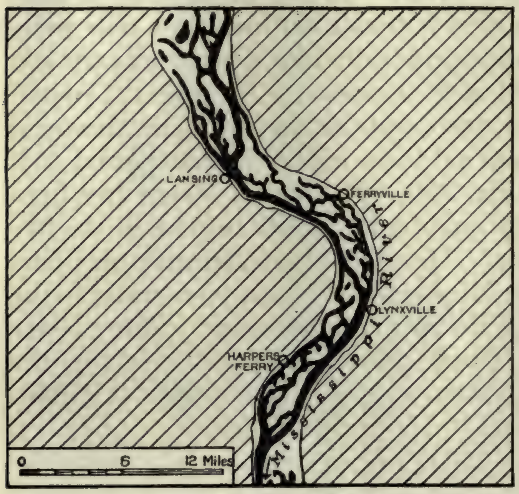


Fig. 95. — A stretch of the Mississippi River between Iowa and Wisconsin. Note the complex channels of the river. (*After Martin, Wis. Geol. Sur.*)

The Lower Mississippi. — South of the junction with the Ohio the Mississippi changes greatly. As you go down the river the rock bluffs are farther and farther apart, and the alluvial plain, widening southward, blends with the low coastal plain. Cairo marks the head of the original delta of the Mississippi.

Over the flood plain, from 20 to 70 miles in width, the sluggish river meanders in great ox-bow curves. From time to time the river cuts through the narrow neck of some of these bends and then abandons the long curve, which becomes one of the many ox-bow lakes that border the river (Fig. 96).

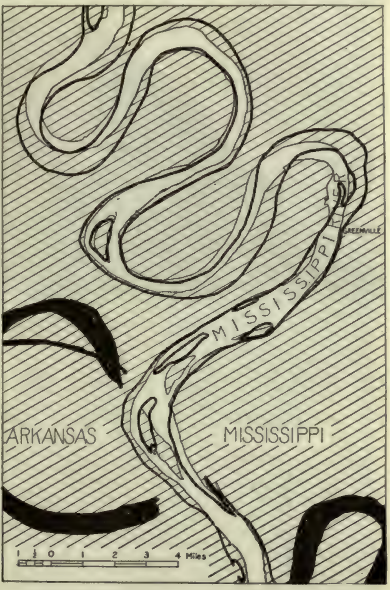


Fig. 96. — Meanders in the lower Mississippi. The black areas are ox-bow lakes in abandoned channels of the river. (*After Martin, Wis. Geol. Sur.*)

The Natural Levees. — The Missouri brings to the Mississippi an enormous amount of silt, making the water yellow. So slight is the grade of the river that at low water the stream flows lazily and deposits sand bars at frequent intervals. For ages past, at flood stages, the river has overflowed its banks and covered its flood plain, slowly building it up by the sediments which it deposited. More sediment was deposited near the river than at a distance, and this caused the building up of low embankments, called *natural levees*, on either side of the river (Fig. 97). Since these are a little higher and drier than land some distance back from the river, the levees are selected as sites for plantations and towns and for the roadbeds of railroads. New Orleans is built on such a natural levee.

The Problem of Controlling the River. — So great is the area of land whose waters drain into the Mississippi and so large is the annual rainfall that at times the river is forced to carry an enormous volume of water. The Ohio is the greatest contributor. Nearly every spring the flood waters rise to a dangerous height, overflowing the banks, breaking through the levees, and inundating

Fig. 97. — Levee along the lower Mississippi in Louisiana. (*U. S. Bur. of Soils.*)

the lowlands. To prevent this overflow, artificial levees or dikes of earth have been built. They are partially, but not wholly,

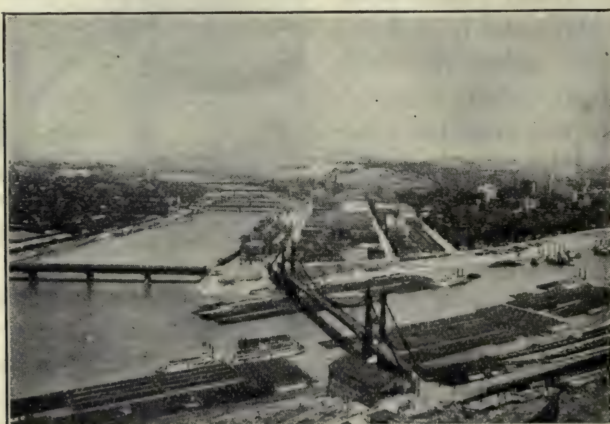


Fig. 98. — Junction of the Allegheny and Monongahela rivers at Pittsburgh. Coal barges in the foreground. (*Physiography Lab. Cornell Univ.*)

successful; floods still break through the dikes and a serious loss of life and property sometimes follows. The national government and the states most interested are struggling with the

problem which will be partially, if not wholly, solved by completing the line of dikes and building them higher and stronger.

Fig. 99. — Royal Gorge of the Arkansas River, 2600 ft. deep, through the Front Range of the Rocky Mountains in Colorado; an impressive example of river erosion. (*Courtesy D. & R. G. R. R.*)

Principal Tributaries of the Mississippi

The Ohio (967 miles long) is less than half as long as the Missouri (2400 miles), and its drainage basin has less than one-half the area, yet it pours twice as much water into the Mississippi. This is due both to the heavier rainfall and to the smaller evaporation and less seepage into the soil. The Ohio has been one of our most important rivers. It has been designated by Congress as the first river to be extensively improved for navigation; 54 locks and movable dams are being constructed in an effort to secure a 9-foot channel the entire length of the river. These improvements will cost well toward $100,000,000.

The Missouri heads in the Continental Divide in Montana, and is longer than any European river; it is one of the muddiest of streams, carrying more than 100,000,000 tons of silt annually. In the region of Great Falls, Mont., it takes five successive plunges, 612 feet in all, thus yielding great water power. At times of high water it was considerably used for navigation until its territory was traversed by railroads. At low water it is very shallow and is now scarcely used at all for navigation.

The Arkansas and the Red rivers are long, shallow streams, entering the lower Mississippi from the west. Improvements for the benefit of navigation have been made by the government, but only a small amount of traffic is maintained. Where the Arkansas cuts its way through the eastern range of the Rocky Mountains, in Colorado, it has carved one of the most famous gorges of the West, the Royal Gorge of the Arkansas; it is more than 2500 feet in depth with almost perpendicular walls, and is one of the scenic features of the Rockies (Fig. 99).

The Rise and Decline of the Mississippi as a Commercial Waterway

Three Periods. — People who now live near the Mississippi River and see only the occasional passing of a steamboat can scarcely picture to themselves the scenes on that river before the

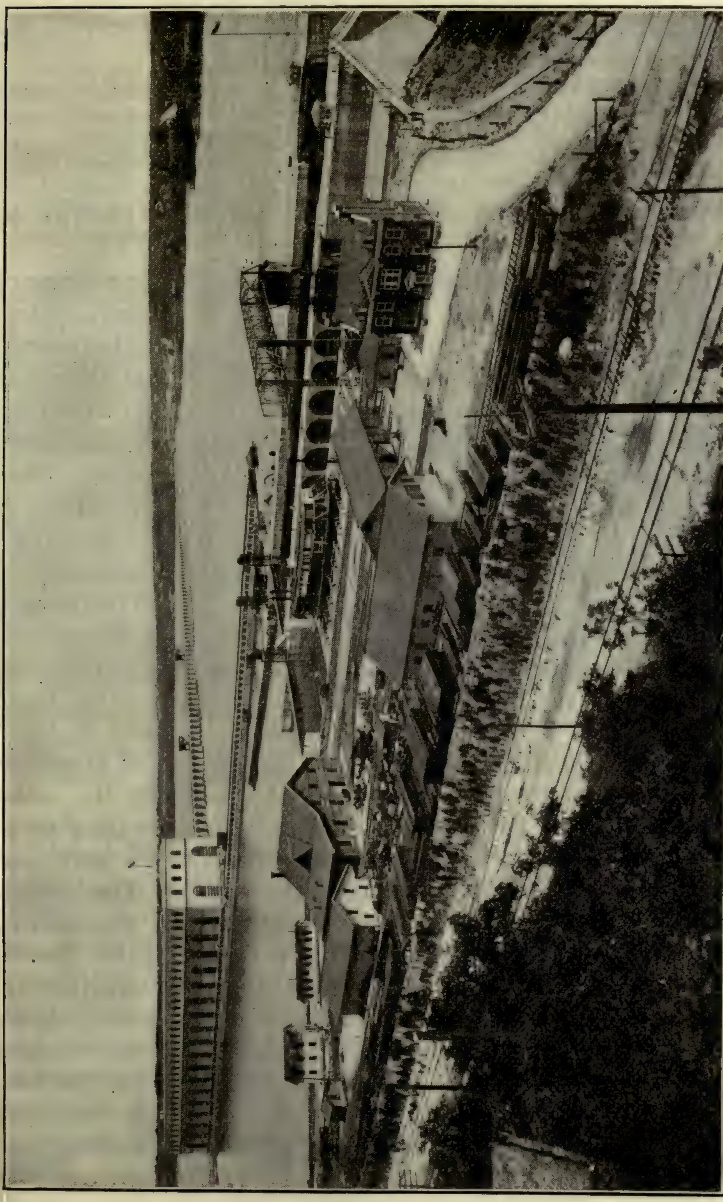


FIG. 100. — Power house, lock, dry dock, and dam across the Mississippi at Keokuk, Iowa. (*Courtesy Miss. R. Power Co.*)

day of railroads. It is convenient to divide the history of the Mississippi River navigation into three periods:

1. The period of the canoe and flatboat, extending to the decade between 1820 and 1830.

2. The period of greatest steamboat traffic, ending between 1850 and 1860.

3. The period of decline and possible recovery, 1860 to the present.

The Period of the Canoe and Flatboat. — From the days of the first fur traders until about 1800, the Mississippi system formed a network of waterways traversed mainly by canoes. At several places in Wisconsin, Illinois, Indiana, and Ohio, the headwaters of streams flowing toward the Mississippi were near streams flowing to the Great Lakes. Before the white man came, the Indians had already located these "portages," as they came to be called (from the French word meaning "to carry"). The canoes were paddled as far as possible up one river or creek, carried across the portage to another flowing in the opposite direction, whence they proceeded down that stream. Waterways were almost the only highways, and the light canoe, which could be carried around falls and rapids or from one stream to another, was almost the only means of traveling or carrying goods in those early days.

In 1803 the United States purchased the territory of Louisiana from France and thus secured control of practically the entire Mississippi basin. Even before this an ever increasing number of pioneer settlers had been pouring through the gaps and passes of the Appalachian Mountains into the West. They settled along the rivers, raised crops, and sought markets in which to sell them. But nearly all these streams led to rivers that flowed, not toward the east, but toward the Mississippi. Hence the surplus wheat, pork, flour, corn, furs, lead, etc., produced in the region west of the Appalachians, found its easiest outlet to markets by going down the rivers to the Mississippi and to New Orleans, whence much of it was taken to cities on the Atlantic seaboard, to Europe, or elsewhere. It was a long, roundabout journey.

During this period the flatboat became important. It was a crudely built affair, perhaps 15 feet wide by 40 feet long. It rose but little above the water, and its broad, flat bottom sank but little below the surface. It floated downstream, but had no means of returning against the current; hence it was, as a rule, broken up and sold for wood or lumber at its destination, and its owners returned home as best they could. Before the coming of the steamboat, the flatboat was the principal means of moving heavy freight downstream. The upstream traffic was small and was mainly carried in keel boats and barges propelled by poles, oars, or sails, and sometimes towed by ropes.

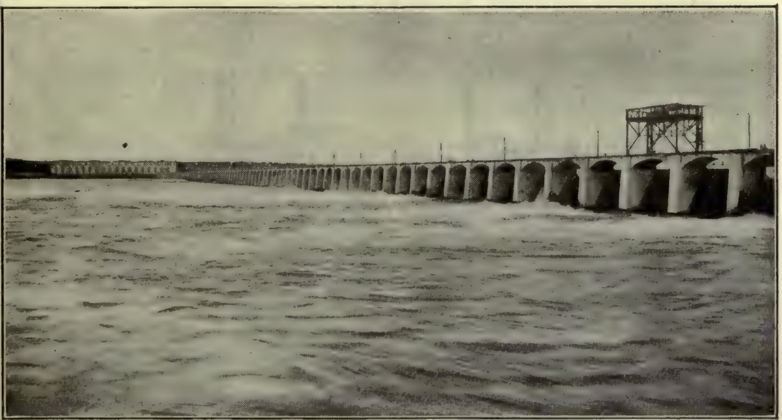


Fig. 101. — The great dam, nearly a mile long, across the Mississippi River at Keokuk, Iowa. In the distance is the power house where 15 monster dynamos generate electricity that is sent to surrounding places, including St. Louis, 144 miles away. (*Courtesy Miss. R. Power Co.*)

Second Period: The Rise of Steamboat Navigation. — Steamboats began making trips on the Ohio and Mississippi soon after 1810, and their coming wrought a mighty change. Then upstream traffic as well as better downstream traffic became possible. Railroads were yet unknown and good highways scarcely existed; rivers were still all-important. Our western rivers probably will never again play such an important part in the life of the nation as they played between 1820 and 1860. The coming of the steamboat reduced a week's journey to a day's; passenger and freight rates gradually fell to a quarter of their former level.

Farming became profitable and settlers flocked into the West by thousands, particularly after the Erie Canal was opened in 1825.

New Orleans doubled in population between 1830 and 1840. In 1834 there were 230 steamboats plying our western rivers, and by 1850 there were more than 1200, carrying a commerce of over $500,000,000 a year. In the years between 1840 and 1850, upwards of 2000 steamboats a year arrived at St. Louis and from 4000 to 5000 passed Cairo, Ill. This was the high

Fig. 102. — Excursion steamers in the lock at the Keokuk dam, Keokuk, Iowa. By means of this lock, boats pass the great dam shown in Fig. 101. (*Courtesy Miss. R. Power Co.*)

tide of steamboat navigation. Rivers carried the vast majority of the products of the West. In 1851, 97% of the beef, 96% of the corn, and 97% of the flour sent from Cincinnati went down the Ohio by boat. The wharves of Pittsburgh, Cincinnati, Louisville, St. Louis, Memphis, and New Orleans were thronged with river craft. Writing of this period, Miss Ellen Semple says: "On the large, elegantly equipped passenger boats, which made regular winter trips between Cincinnati or St. Louis and New Orleans, gay social life with nightly balls gave to river travel on the Mississippi a local color such as it acquired nowhere else. Less than fifty years from the ripple of the fur-weighted pirogue . . . to the monotonous splash of the big paddle wheel and the floating palace with its lights, music, and the polished society of the generous Southland."

Third Period: The Decline of River Navigation. — The first railroads in the United States were built as early as 1830. The first one to reach the upper Mississippi was the Chicago and Rock Island in 1854. Others soon followed and made connections with routes to the eastern states where western produce was in demand. The Mississippi and its branches had performed a most valuable service, but they led by very long routes to eastern markets. The railroads, crude as they were in the beginning, were more rapid than boats and led either directly to the East or to water routes by way of the Great Lakes and Erie Canal. The Civil War seriously crippled traffic on the Mississippi and hastened the decline which had already begun. Year by year steamboat owners on the western rivers found their profits diminishing; as boats became old they were abandoned and were not replaced; many were destroyed during the war.

Steamboat arrivals at St. Louis numbered 3626 in 1853 and 2800 in 1870. River shipments from this city amounted to 600,000 tons in 1890, but to only 89,000 tons in 1906, while shipments by rail from St. Louis rose from 5 million to 17 million tons in the same time. Aside from coal carried down the Ohio to the Mississippi, river traffic declined to a very small fraction of its former magnitude.

After the World War, the United States Government attempted to restore river traffic between New Orleans and St. Louis. Some 40 steel barges and 10 tug boats were operating under government contract in 1921 and a large amount of freight was being carried.

Reasons for the Decline of River Navigation. —

1. The increased efficiency of railroads
2. The decline in railroad freight rates from 1860 to 1900
3. The effort of railroads to destroy river traffic
4. The public demand for swifter and more certain service than rivers afforded
5. The cost of keeping rivers dredged and otherwise improved to meet modern needs

The waterways problem is one of the great questions before the American people. Shall we expend millions of dollars annually

in an effort to make and keep rivers navigable? There are arguments on both sides. What our government's policy in this particular should be is far from clear. The millions that we have been spending yearly on our rivers have not checked the decline in their use. Rivers vary enormously in volume, the Mississippi at Cairo sometimes rising 50 feet. They are constantly silting up their channels; this is especially true of the Missouri and lower Mississippi. Our largest rivers do not flow in the direction required by the principal movements of trade. The government's method of making river improvements is costly and unsystematic. Our past experience causes some people to doubt the wisdom of continuing a policy of river improvement that will call for hundreds of millions of dollars, but others believe such a policy to be desirable.

The Great Lakes as a Commercial Waterway

Character of the Waterway. — The Great Lakes are the leading inland waterway of the country because:

1. They are deep enough for boats of great size;
2. They extend east and west, the direction of the heaviest freight movement;
3. They are in a region that has a large population and supplies an enormous tonnage of iron ore, coal, and grain;
4. They require comparatively little outlay for maintenance.

Niagara Falls form the most important obstruction in this route, but they may be passed by the Welland Canal in Canada, which is being enlarged. This canal is much used by Canadian but little by American vessels (Fig. 92). So far as American traffic is concerned the Great Lakes waterway practically ends at Buffalo. The many locks in the Welland Canal make passage slow. Tolls are charged, and the United States has no important port on Lake Ontario or the St. Lawrence.

Between Lake Superior and Lake Huron are the St. Marys Falls or Rapids (usually referred to as Sault Sainte Marie or "the Soo"). Around these are three canals, one belonging to Canada and two to the United States.

The chief drawback to this great waterway is the fact that it is closed by ice during the five cold months of each year. For many years the Erie Canal formed a very important connection between the Lakes and the Atlantic, but this waterway declined with the increased use of railroads. The enlarged Erie Canal, often called the New York Barge Canal, has not yet shown whether or not it will be an important waterway.

Present Traffic on the Lakes. — The wonderfully rich iron ores mined around Lake Superior supply over 60 per cent of the freight

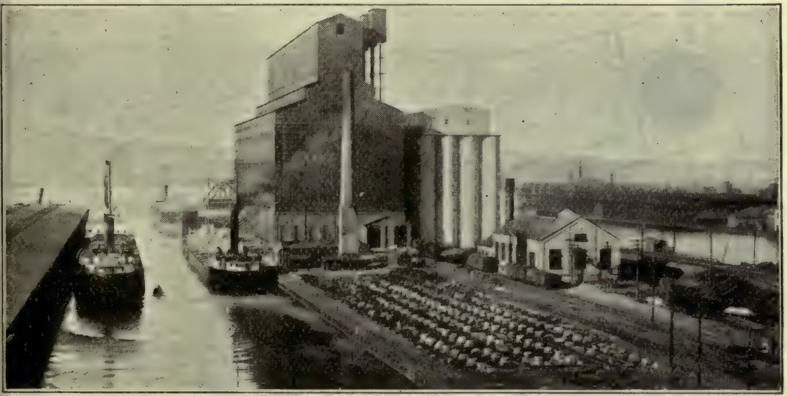


FIG. 103. — Enormous grain elevator at Superior, Wisconsin, at the head of Lake Superior.

carried on the Lakes. Specially designed steel steamships of great size, 500 to 700 feet long and carrying as high as 15,000 tons of ore, ply between ports at the head of Lake Superior and cities on Lake Michigan and Lake Erie. The tonnage of freight passing through the St. Marys canals rose from a little over a million tons in 1880 to 80 million tons in 1920. The tonnage (not value) of freight which passes through the Detroit River in seven months is about five times as great as that which passes through the Suez Canal in a year. The tonnage of the vessels on the Great Lakes is 20 times as great as that of the vessels navigating all the rivers of the Mississippi system, and was about double that of Ameri-

can vessels on the ocean engaged in our foreign trade prior to 1917.

The freight rate on ore and coal before the World War was very low, sometimes as low as one-twentieth of a cent a ton per mile; yet the big ore-carrying boats earned upwards of $1000 a day. They make the round trip between Duluth or Superior and Lake Erie ports in about a week.

Importance to the Steel Industry. — It happens that our greatest iron mines (near Lake Superior) are situated nearly a thousand

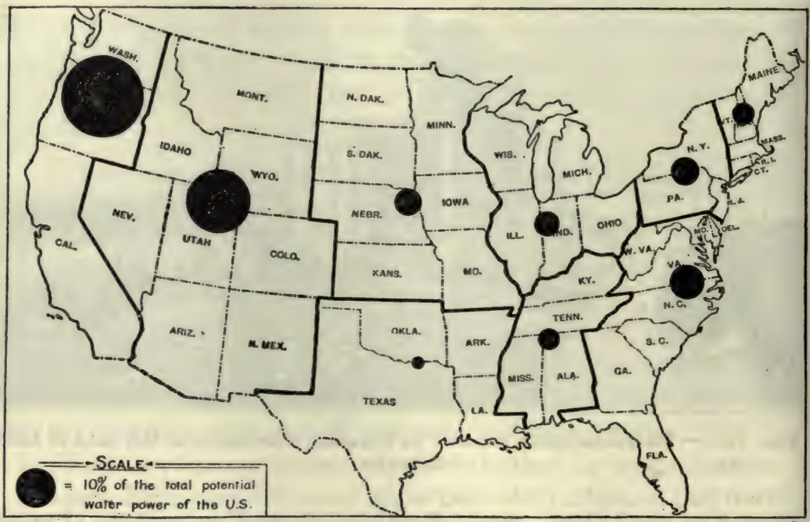


FIG. 104. — Map showing the comparative potential water power in the nine groups of states.

miles from the mines which yield the best coal for making coke (in western Pennsylvania). Before the iron ore can be smelted, the ore and coke must be brought together. The lake steamers carry a ton of coal or iron ore a thousand miles for less than the charge of hauling it a hundred miles by rail.

Growth of Cities on the Mississippi and on the Great Lakes. — The commercial decline of the Mississippi and the rise of the Great

Lakes as a waterway are strikingly illustrated by the fact that while the six leading cities on the Ohio and Mississippi gained about 325,000 population from 1910 to 1920, the six leading cities on the Great Lakes waterway gained 1,620,000 in the same period.

Rivers as Sources of Power

The Use of Water Power, Past and Present.—Until electricity came into use, water power could be employed only at the actual place where it existed. Now it may be converted into an electric current and conveyed scores or even hundreds of miles. Most of

FIG. 105. — Locations of important water powers in the Carolinas. Squares indicate power owned by manufacturers, and circles power owned by water power companies. A great deal of this power is used by the cotton mills. (*U. S. Comr. of Corp., 1912.*)

the great water power plants installed in recent years are hydroelectric plants, or those which convert the water power into electricity. Such are the great power houses at Niagara Falls, at Keokuk on the Mississippi (Fig. 100), at Great Falls, Mont., and at various places in Colorado, Washington, California, the Southern Appalachians, and elsewhere.

Many mills and factories, especially in the eastern states, are still situated close beside the rivers at points where the falls or rapids occur, and their machinery is driven directly from the re-

volving water wheels. New England's early start in manufacturing was greatly aided by abundant water power, and many of her leading cities are located at water power sites. The banks of the Merrimac in southern New Hampshire and Massachusetts are dotted with mills. Fall River, Mass. (cotton); Holyoke, Mass. (paper); Paterson, N. J. (silk); Rochester, N. Y. (flour); Grand Rapids, Mich. (furniture); Minneapolis, Minn. (flour); and a long list of other places belong to the group of water power cities.

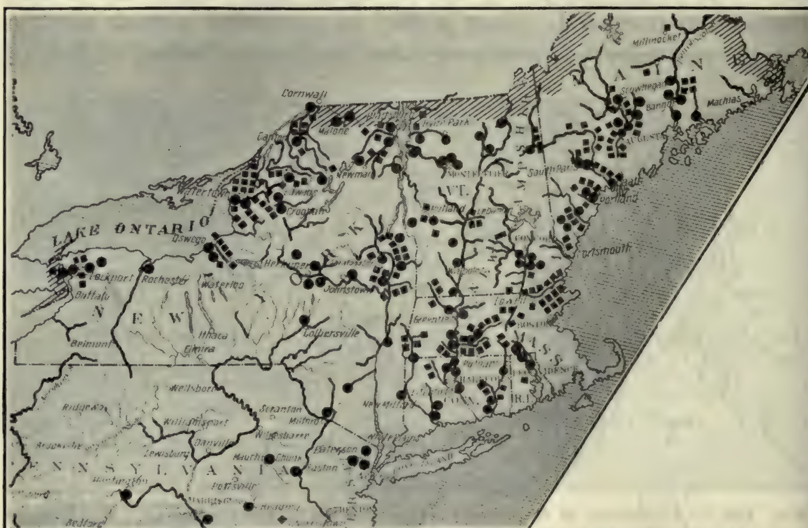


FIG. 106. — The many important water powers of New England and New York. Squares indicate power owned by manufacturers, and circles power owned by water power companies. (*U. S. Comr. of Corp., 1912.*)

Development of Water Power in the South. — The swift streams of the Southern Appalachians are being harnessed for manufacturing purposes, notably for the making of cotton goods. Along the east-flowing streams in North Carolina, South Carolina, and Georgia, and to a smaller extent on the western side of the Appalachians in Tennessee and Alabama, mills and factories have been built in large numbers. One-third of our cotton spindles are in this region (Fig. 105).

Water Power and the Manufacture of Paper. — Most of our paper is made from wood pulp. A great amount of cheap power is needed in this industry and so the chief paper-making centers are in the northern parts of New England, New York, Michigan, and Wisconsin, where swift rivers and forests of spruce and other soft woods were found near together (Fig. 106).

Western Rivers

Important Western Rivers. — The Columbia and Snake rivers and their branches form the drainage system of our Pacific Northwest. Into the great lava plateau these rivers have cut cañons from a thousand to two thousand feet in depth. By means of locks at two points the Columbia has been made navigable for 400 miles from its mouth. Ocean vessels ascend the Columbia and Willamette 110 miles to Portland. The Salmon fisheries of the Columbia River and the Colorado with its wonderful cañon are described elsewhere. Portions of the Sacramento and of the San Joaquin in California, a short lower stretch of the Colorado, and a long stretch of the upper Missouri are classed as navigable rivers, but, with the exception of the Sacramento, they are little used.

Character of the Western Rivers. — Of the 26,000 miles of navigable rivers in the United States, only 2000 miles are in the western half of the country. There are seven western states that contain no navigable rivers. For reasons to be explained later, the rainfall over these states is small, except along the coast north from San Francisco, and on the higher mountains, most of which collect a good deal of snow. Many of the rivers flow long distances through arid regions and lose a considerable part of their water by seepage and evaporation, and in late summer they may dwindle to mere creeks. The Rio Grande, for example, in certain places almost disappears for miles, flowing in the gravel of its bed. After heavy rains in the mountains or when the snows are melting, the mountain streams become torrents and sweep down their

FIG. 107. — Water power development in California. The circles represent hydro-electric power plants that sell power. The squares represent plants that use power directly for manufacturing purposes. (*U. S. Comr. of Corp., 1912.*)

courses with terrific violence, carrying everything before them; but at other times they may become almost dry.

Irrigation

The Growth of Irrigation in the United States. — Irrigation is one of the oldest devices of civilized man; it was practiced in ancient Egypt, India, Mesopotamia, China, and among certain tribes of American Indians. The first Americans to use irrigation in the West were the Mormons, who entered Utah in the forties,

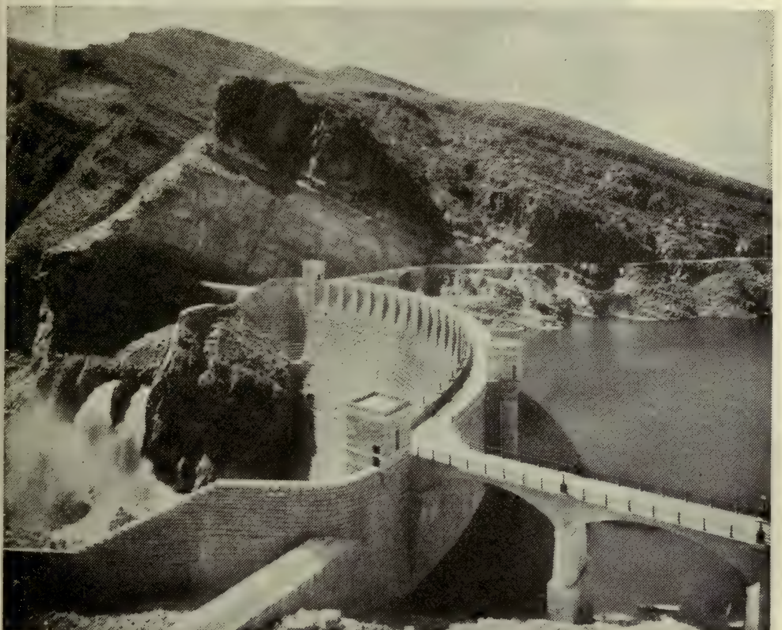


Fig. 108. — The Roosevelt dam in Arizona. By means of this dam a lake is produced which stores enough water to irrigate 170,000 acres of land.

while that region still belonged to Mexico. In the last quarter century its use has spread into hundreds of our western valleys. The progress from the first simple irrigation dams and canals of the early settlers to the great masonry dams and canals constructed by the United States Government makes a remarkable story (Fig. 108).

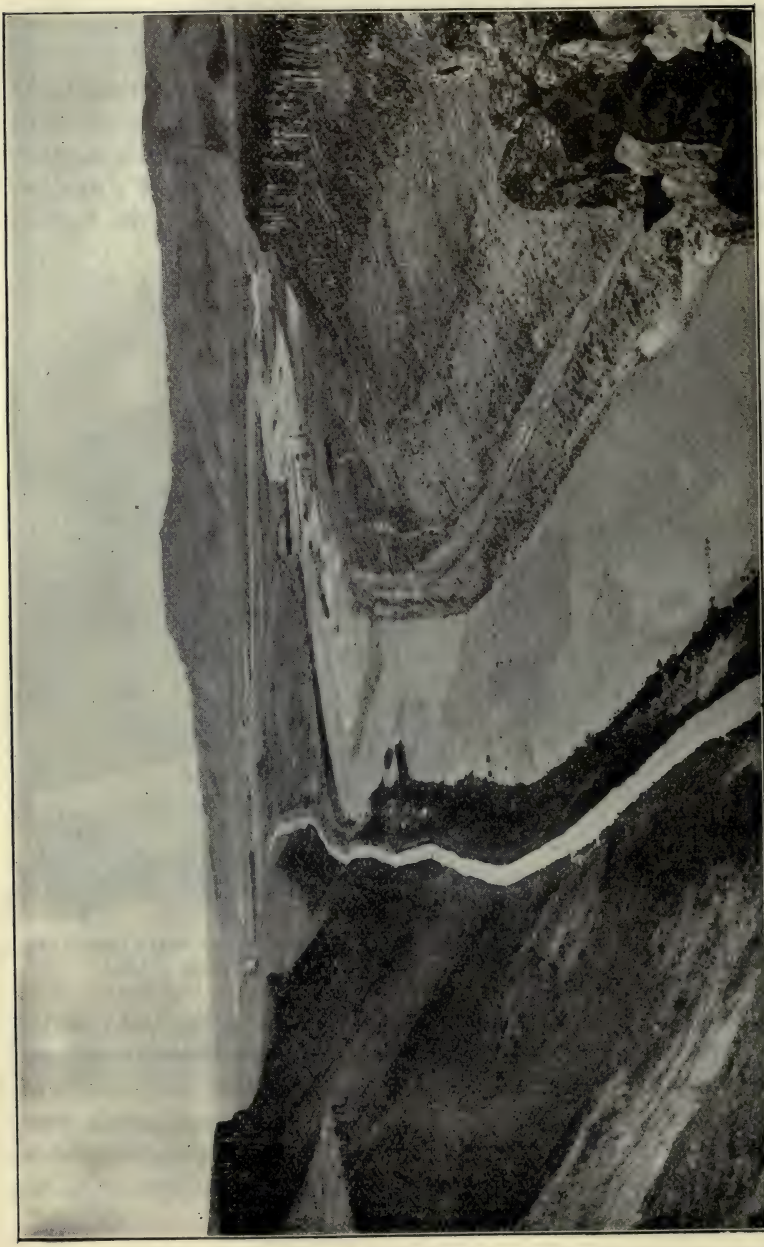


FIG. 109. — Irrigation canal in Idaho. A main canal of this kind, shown at the left, conducts the water from an up-river point to the lands that are to be irrigated. (*U. S. Rec. Service.*)

Extent and Methods of Irrigation. — In many of the western valleys the land is rich in plant food, and sunshine is abundant, but rainfall is inadequate. The larger part of the land of eleven western states cannot grow crops without irrigation. In 1921 about 15 million acres, an area half as large as New York, was under irrigation. This exceeds the *cultivated* area of Massachusetts, Connecticut, Vermont, Rhode Island, New Jersey, and Delaware

Fig. 110. — Irrigated fruit lands in the Grand Valley of Colorado. (*U. S. Rec. Service.*)

combined, yet it is less than 3 per cent of the arid land of the West. Most of the irrigating is accomplished by building dams which hold the flood waters in reservoirs to be used during the dry summer. By means of main canals, branch canals, and ditches, this water is distributed over the valley lands (Fig. 109). In a few states, mainly in California, water from wells (about 20,000 in all) is used.

The great majority of the fifty or sixty thousand irrigation enterprises in the United States include only a few hundred acres each, but some of the private enterprises, and all of the United States Reclamation projects (about 30), include thousands of acres each, a few of them exceeding 200,000 acres, equal to a small county.

The less expensive projects have been established by individual

FIG. 111. — Irrigated lands in the Santa Clara Valley of California. (*U. S. Geol. Sur.*)

farmers or groups of farmers or by irrigation companies, but large projects costing millions of dollars have been carried out by the government through the Reclamation Service; yet a great deal more land is irrigated by private individuals and corporations than by the United States Government through the Reclamation Service.

Irrigation Farming. — Undoubtedly irrigation farming has many attractions. The farms or ranches are usually small and care-

fully cultivated, and weather conditions are more dependable than in a humid climate. The people who have settled on the irrigated lands are progressive, and social conditions are usually excellent. Orchards and vineyards of 10 or 20 acres, when successfully managed, may yield their owners as much profit as 160-acre farms in the Middle West or East. While such instances are numerous, they show what is possible rather than what is common; indeed, only about one-twentieth of the irrigated land is devoted to fruit; more than three-fourths produces grain, hay, and alfalfa; to the last-named crop nearly one-third of all our irrigated land is devoted.

EXERCISE XI

Suggestion. — It is suggested that pupils prepare to discuss the foregoing chapter by the topical method, using the following topics:

1. The importance of rivers in the exploration and settlement of North America
2. Early methods of travel and transportation in the United States
3. Dependence of the fur trade on rivers
4. The importance of rivers to agriculture in the American colonies
5. Rivers and early manufacturing
6. The historic and economic importance of the St. Lawrence system
   - (*a*) Early history
   - (*b*) Importance to Canadian commerce
   - (*c*) Physical features of the St. Lawrence
7. The Mississippi River
   - (*a*) Features of the upper Mississippi
   - (*b*) Features of the lower Mississippi
     The natural levees
8. The problem of controlling the river
9. Principal tributaries of the Mississippi
   - (*a*) The Ohio: its past and present usefulness
   - (*b*) The Missouri
   - (*c*) The Arkansas and the Red
10. The navigation of the Mississippi: three periods
    - (*a*) The period of the canoe and flatboat
    - (*b*) The rise of steamboat navigation
    - (*c*) The decline of river navigation
11. Reasons for the decline of river navigation
12. The waterways problem
13. The Great Lakes as a commercial waterway
    - (*a*) Character of the waterway
    - (*b*) Present traffic: its great volume and low cost

(*c*) Importance to the steel industry

14. Rivers as sources of power
    (*a*) The use of water power past and present
    (*b*) The development of water power in the South
    (*c*) Water power and the manufacture of paper
15. Important western rivers
16. Character of the western rivers
17. Irrigation
    (*a*) Growth of irrigation in the United States
    (*b*) Extent and methods of irrigation
    (*c*) Irrigation farming

CHAPTER IX

SIX OF THE WORLD'S GREAT RIVERS [1]

The Amazon and Brazil

Size. — The Amazon is the monarch of rivers. Though not quite so long as the Mississippi-Missouri, its basin is much larger,

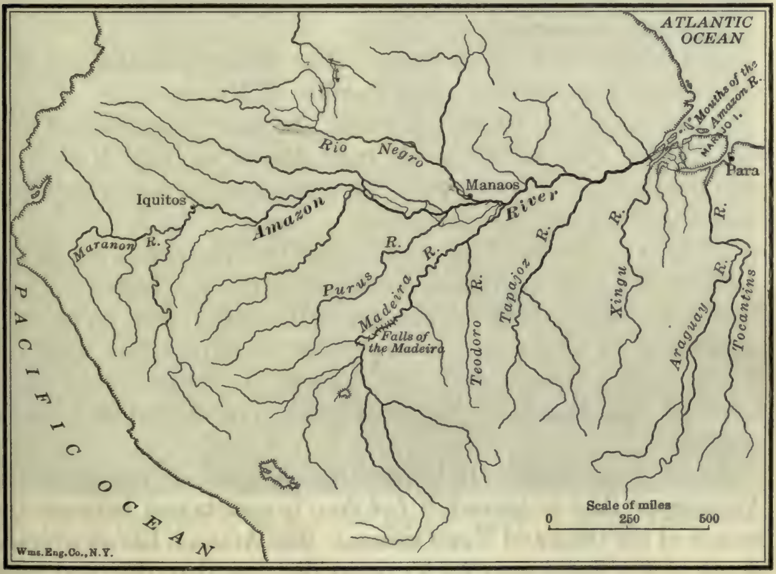


Fig. 112. — The Amazon River system.

and it pours into the ocean a much greater volume of water. Rising in the lofty Andes within a hundred miles of the Pacific,

[1] Large American rivers are described in Chapter VIII. This chapter is designed for reading rather than for careful study.

it flows in a course nearly 4000 miles long into the Atlantic. No other river cuts its continent so nearly in two.

For almost its entire length the Amazon flows near the equator and parallel to it; thus it is in a region where the rainfall is very heavy. Over the larger part of the basin the rainfall amounts to from 6 to 8 feet (72 to 96 inches) per year, and much of the land is so low and flat that at times of flood vast areas are under water.

The great river does not flow in a single channel, but is like a braid of many strands. There are so many islands and so many channels that the traveler almost never sees the whole width of the mighty river. Near its mouth it becomes a hundred miles wide, and from the middle neither bank can be seen.

Important Features. —

1. *The great size of its basin.* The Amazon drains an area larger than that of all Europe outside of Russia.

2. *Its enormous volume of water.* It pours more water into the Atlantic than all the rivers from Alaska to Cape Horn pour into the Pacific. So powerful is the current that it forces its yellow waters 200 miles out into the ocean.

3. *Its exceedingly slight grade.* On the eastern slope of the Andes the headwater streams make terrific plunges, but in the final 2000 miles of its course the Amazon falls only 35 feet, an average of two-tenths of an inch to the mile. Contrast this with the St. Lawrence, which falls 250 feet in its lower course in a tenth of this distance. No other great river has such a gentle gradient.

4. *Its great depth.* It is only by constant dredging of the Mississippi that a channel *9 feet deep* is maintained between the mouth of the Ohio and New Orleans. The Amazon has an average depth of *100 feet or more* for a greater distance than this, and from the mouth of the Rio Negro to the sea the river is about 200 feet deep. Ocean steamships ascend 2300 miles to Iquitos in Peru, and steamers drawing 14 feet of water may ascend 480 miles farther. No other large river of the world even approaches such depth for such a distance.

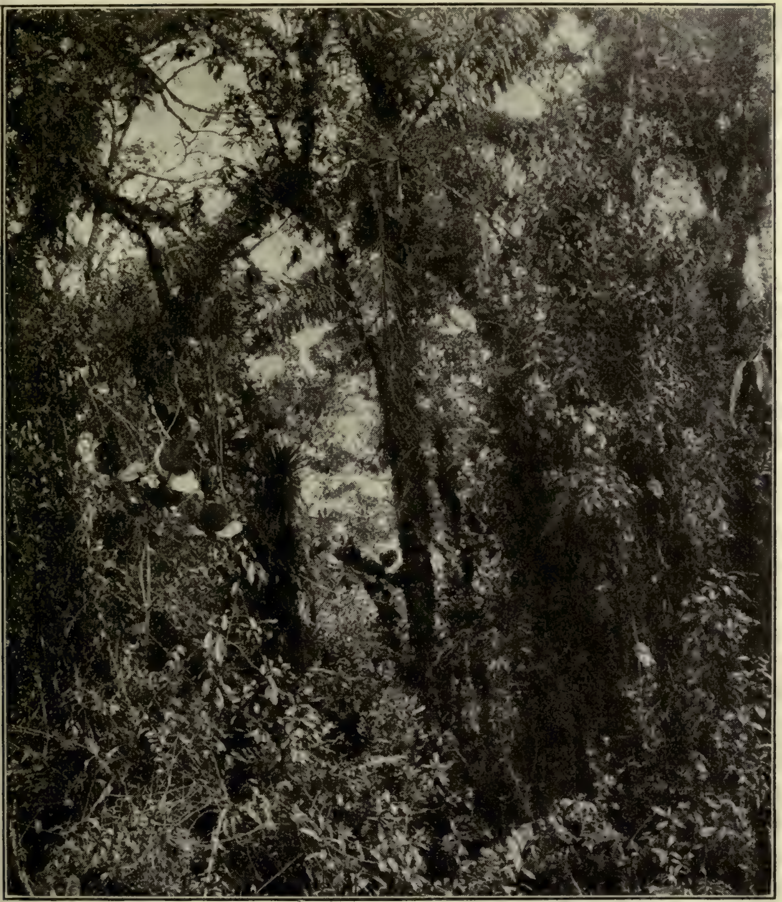


FIG. 113. — Vegetation of the hot, wet Amazon jungle. *(Courtesy Isaiah Bowman, Am. Geog. Soc.)*

5. *The great number and size of its tributaries.* Fourteen of these are as long as the Rhine or longer, and of much greater volume, and at least one is as long as the Mississippi.

The Amazon Jungle. — The larger portion of the Amazon basin is a vast, uncultivated, almost unpeopled wilderness. There are

great stretches of morass in which the dense tropical forest is woven together by a tangle of undergrowth and vines looping from tree to tree or hanging from every limb. The Amazon forests form one of the most impenetrable jungles found anywhere in the world, and if it were not for the rubber trees most of the wilderness would still be little known to the outside world (Fig. 113).

Comparison of the Amazon and Mississippi Valleys. — The Amazon basin is an impressive example of the way in which a bad climate may almost completely block the development of a region. Aside from climate and the consequences of climate, the basin of the Mississippi is not unlike that of the Amazon; yet one teems with prosperous and progressive people, is dotted with cities, crisscrossed by railroads, and sprinkled with churches, schools, colleges, and libraries; both its agricultural and manufactured products are measured in billions of dollars a year; the other has not a single large city;[1] in most of its area there is not a mile of road or railroad, not a mill or factory, not a school or church, not a cultivated farm or a white man's permanent home. The state of Amazonas contains an average of only about one person to three square miles.

In the four hundred years since Europeans penetrated the Amazon Valley little progress has been made there, but the valley of the Mississippi, on the contrary, has had a phenomenal development. What caused the difference? The answer lies mainly in the single word, *climate*. This is an example of geographical influence that is worth remembering. Just a difference in the angle of the sun's rays and in the amount of rain that falls, and one valley is a tropical jungle while the other is the home of millions of progressive people and the heart of the world's richest nation!

Navigation. — The Amazon and its tributaries are constantly used for navigation. Practically all of the products of its basin, rubber, cabinet woods, Brazil nuts, and cacao, reach the outer world by way of the river, and all of the supplies are carried in by the same route. Regular lines of steamers ply up and down the river and

[1] Manaos, the chief city, had a population of about 50,000.

its chief tributaries. Ocean-going steamships load at Iquitos or Manaos, the chief cities of the interior, and proceed directly to ports of the United States and Europe. Smaller boats visit the rubber-collecting centers on the many rivers, and carry the rubber to Manaos or to Para (population 100,000) at the mouth of the river; moreover, a part of the products of Bolivia and Peru reach the outer world by way of the Amazon. The Madeira, one of the great tributaries, has a series of 13 falls and rapids around which a railroad 200 miles long has been built.

A peculiar condition exists at the headwaters of a branch of the Amazon and a branch of the Orinoco: the two rivers are united by a stream of considerable size (the Casiquiare), and at high water small boats may pass from one of these great river systems to the other.

The Rhine and Germany

Importance to Germany. — The Rhine is the most historic of European rivers. From the days of Julius Cæsar down through the struggles of the Middle Ages to the present, the valley of the Rhine has been the scene of stirring events. It has been for more than a thousand years the principal link in the great north-south road across Europe, uniting the Mediterranean with the North Sea and the Baltic. More myths and songs and legends are associated with the Rhine than with any other part of the German Fatherland. The historic river is singularly woven into the affections and patriotism of the German people.

Physical Features. — Though only 800 miles in length the Rhine rises in one country, flows across a second, and enters the sea through a third. Its headwaters are collected from lakes and glaciers of the Alps. Flowing through the beautiful Lake Constance, it reaches the Swiss frontier at the city of Basel. Of the 233 miles in Switzerland very little is navigable even for small boats (Fig. 114).

Between Basel and Bingen (224 miles) the Rhine winds over a flood plain 20 miles in width. Through part of this distance

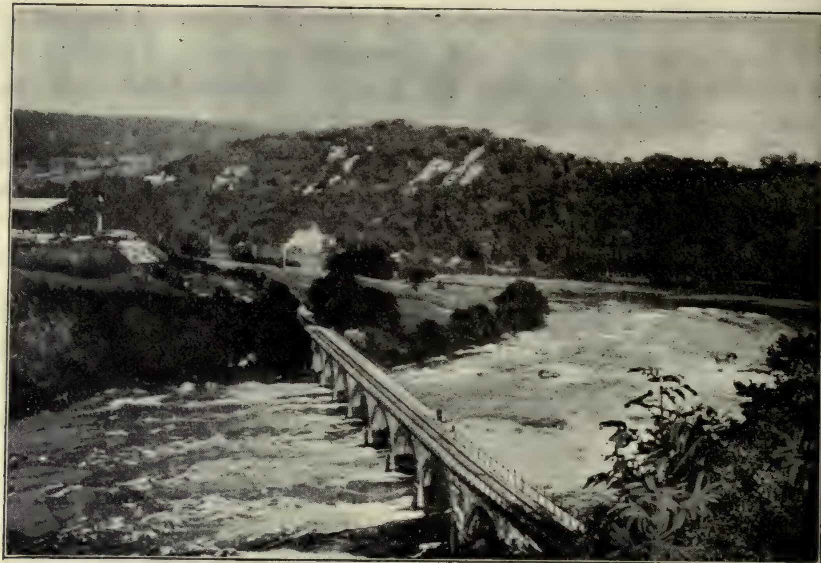


FIG. 114. — The turbulent Rhine near the place where it crosses the Swiss boundary into Germany. (*Courtesy W. H. Dudley.*)

the river forms the boundary between Germany and France. For more than a hundred years, the cities and provinces along this section of the Rhine have been engaged in straightening the river, building embankments and walls to check its overflow, and narrowing it here and there to concentrate its current and prevent silting. By cutting across the necks of the great meanders, the river has been shortened 45 miles in this portion (Fig. 116). The navigation of this part of the river is mainly confined to the stretch below Mannheim.

Between the cities of Bingen and Bonn the river traverses an ancient plateau. This portion, 79 miles in length, forms the famous and romantic "Gorge of the Rhine." Here the valley is narrow, and the valley walls rise steeply; at nearly every curve a frowning height, topped by the ruins of an old castle, commands the river (Fig. 117). Many of the steep slopes are terraced for vineyards. Cities find room for growth only at places where a

Fig. 115. — A part of western Europe. Rhone Valley at the lower left; Alps at the lower right; Rhine Valley at the right; Holland and the Rhine delta at the top.

tributary stream joins the main stream, and railroads hug the river on both sides, finding scarcely room enough for their tracks.

Midway down the gorge, the river Moselle comes in from France.

Northward from Bonn the Rhine crosses the flat North German Plain, passes a succession of great industrial cities and enters Holland, a large part of which is made up of the Rhine delta. Across Holland the river flows in a winding, sluggish course, and enters the sea through many mouths.

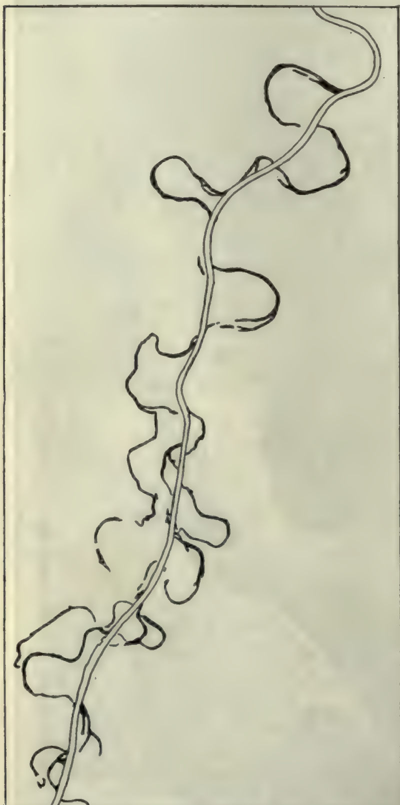


FIG. 116. — Section of the Rhine River. The black lines indicate the former very crooked course of the river; the straightened line shows the present improved channel.

The Rhine in the Middle Ages. — In the Middle Ages there were two important groups of commercial cities — one group in Italy, including Venice and Genoa; the other, the scattered and powerful group known as the Hanseatic League, the most important of which were near the shores of the Baltic and North seas. Between these two regions the easiest route was the valley of the Rhine, and along that river moved the most valuable overland trade of Europe. Scores of petty nobles had their little realms along the Rhine and its tributaries, and at every commanding point some feudal baron built his castle and levied "toll" on passing merchants and travelers. These were the robber barons of the Rhine, whose ruined castles still overlook the river (Fig. 118).

On an average, merchandise doubled in cost for every hundred miles it proceeded along these toll-afflicted routes. Even as late as 1790, there were 29 legalized toll stations between Strassburg and the border of Holland; and in the early part of the nineteenth century every laden boat that passed Cologne or Mainz had to

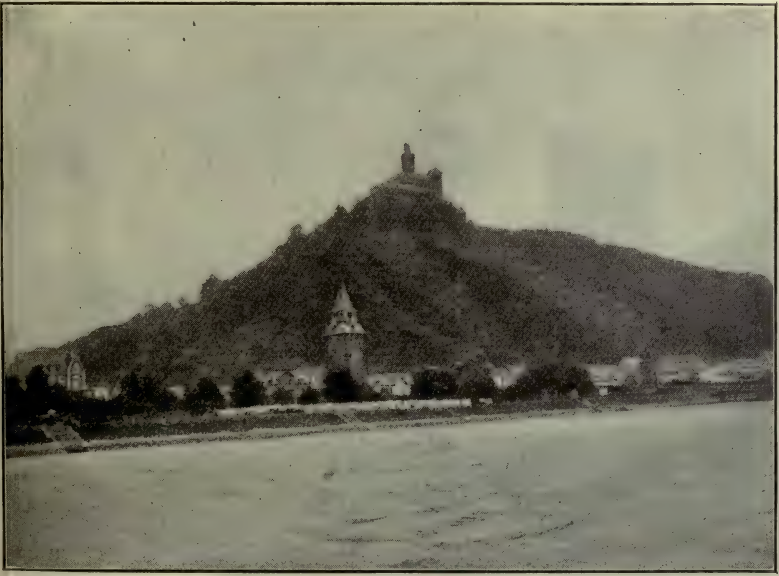


Fig. 117. — One of the many ruined castles on the heights overlooking the Rhine. (*Courtesy W. H. Dudley.*)

unload its cargo and display it for sale in those cities. It was a long, bitter struggle that made the trade of the Rhine safe and free, and that struggle did not end until 1868.

The Rhine of the Twentieth Century. — After the union of the many German states into the German Empire, great sums of money were expended upon the Rhine. It was shortened by straightening curves (Fig. 116), rocky shoals and obstructions were blasted out, shallow portions were dredged, and nearly every city along the river built havens and docks equipped with modern loading and unload-

ing machinery. Below Cologne the navigable depth is nearly 10 feet, between Cologne and St. Goar it is 8 feet, and from St. Goar to Mannheim it is $6\frac{1}{2}$ feet.

Prior to the World War the Rhine fleet consisted of more than 10,000 steamboats and barges. Passenger steamers ply constantly from city to city. Steam tugs tow a train of three or

FIG. 118. — The restored castle Rheinstein, below Bingen on the Rhine. (*Courtesy W. H. Dudley.*)

four barges (Fig. 120), carrying from a few hundred tons to 3000 tons each. As would be expected, the commodities carried by water are mainly coal, iron ore, stone, cement, grain, and other heavy articles. The tonnage of freight carried on German waterways was very large, and, on the whole, the cost was fairly low.

The Rhine flows through one of the most densely populated and productive regions of Europe. There are no less than 20 important cities along the river or directly tributary to it; great coal mines

and iron mines are near by, and its mouths reach three world ports — Antwerp, Rotterdam, and Amsterdam. A network of canals connects the Rhine with the Seine in France, with the Danube, and with the Elbe and other German rivers. The fact that the mouth of the Rhine is controlled by a foreign power and that the great ports which serve the Rhine are in foreign territory is,

FIG. 119. — A characteristic scene in Holland. A large part of the land of Holland is included in the delta of the Rhine. (*Courtesy W. H. Dudley.*)

of course, a disadvantage to Germany. The defeat of Germany in the great World War has completely changed her relations to the Rhine, which can scarcely be called a German river any longer. By the terms of the treaty of peace Germany is forbidden to build or maintain fortifications or to keep armed forces nearer than 50 kilometers (about 31 miles) from the east bank of the Rhine. She no longer controls the river even in her own territory, for it is placed in the hands of an international commission and Allied troops may hold the German territory west of the river for fifteen years.

FIG. 120. — The middle Rhine. Note the long narrow barges towed by a steam tug. A great deal of freight is carried by these Rhine boats. (*Courtesy W. H. Dudley.*)

THE VOLGA AND RUSSIA

Physical Features. — The Volga is the longest river of Europe, as well as Russia's most important waterway, but its volume is less than that of the Danube. It is 2300 miles long, equal to the distance from Boston to the Rocky Mountains, and navigable for 2000 miles. Russia is very poorly supplied with roads and railroads, and its rivers, like those of the United States at an earlier period, have been important avenues of transportation. Time does not count so much in Russia as it does in the United States, and slow-moving river craft are quite satisfactory.

Unlike most large rivers, the Volga does not rise in mountains or flow even in sight of mountains. It begins in one of the greatest of the Russian swamps at the low elevation of 600 feet above sea level,

FIG. 121. — Bridge over the Rhine at Bonn. (*Courtesy W. H. Dudley.*)

flows in a crooked course through a vast plain, and empties into an inland lake, the Caspian Sea. It has one notable peculiarity, — for a large part of its course, it cuts against the right bank, producing earth cliffs of considerable height, while the left bank is low and easily flooded. This gives rise to a peculiar distribution of cities and towns; in the lower three-fifths of its course there are only four important towns on the left bank (east), but over thirty on the right bank (Fig. 122). The river flows through an excellent farming region and from 30 to 40 million people live in its drainage basin (Fig. 123). Canals connect the Volga with rivers flowing into the Baltic, the White, and the Black seas.

Navigation of the Volga. — Since the Caspian Sea is an inland lake in a nearly desert land, the traffic on the Volga is largely upstream. Fifteen times as much traffic formerly reached Petrograd by the Volga canals as reached Astrakhan at the mouth of the Volga. Russia has long been a country of fairs, and the greatest fair regularly held anywhere in the world was held at Nizhni

Novgorod on the Volga in the very heart of Russia. Here, in late summer, gathered tens of thousands of buyers and sellers of almost

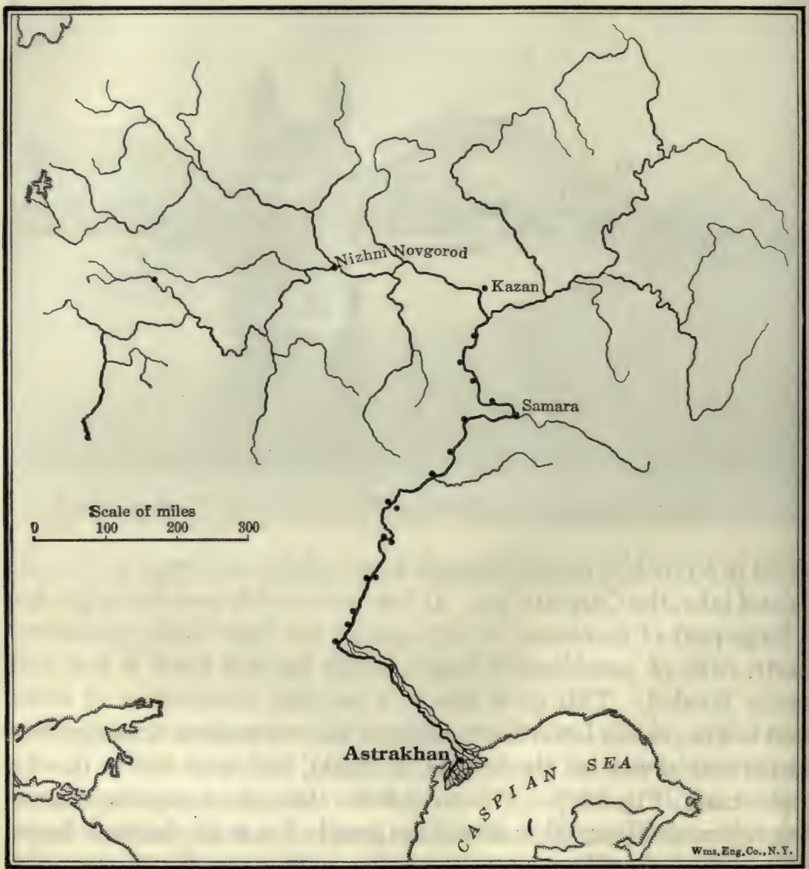


FIG. 122. — The Volga River system, Russia. The absence of tributaries in the southern part of the basin reveals the very light rainfall of this region. Note that most of the cities are on the west bank of the river, which is usually higher ground than the east bank.

everything; traders came from every part of the Empire and of Europe; from Persia, Turkey, and even from the borders of China. Goods to the value of about one hundred million dollars changed

hands each season, and a large part of these came and went by the river. Thirteen thousand boats entered Nizhni Novgorod annually, and 2000 to 3000 entered and cleared at Astrakhan at the mouth of the Volga.

The Volga as a waterway has two drawbacks — its upper portion is icebound for five months, and its lower course for three months, while in a dry summer the water becomes so shallow that navigation is difficult and dredging is constantly necessary. At

Fig. 123. — Modern harvesters drawn by oxen cutting grain on the broad plains of Russia. (*Physiography Lab. Cornell Univ.*)

its mouth the Volga is building a great delta in which the river has some 150 shifting distributaries and 50 regular channels. In the lower Volga, great numbers of sturgeon are caught and from their roe (eggs) the famous Russian caviare is made and widely sold.

The Volga is to be remembered as the most important river of Russia — particularly important in the nation's life because Russia has not passed the stage of development in which rivers are arteries of transportation.

FIG. 124. — The Nile River system.

THE NILE AND EGYPT

Historic Relations. — The Greek historian Herodotus (450 B.C.) called Egypt the gift of the Nile. About all of Egypt that produces crops is a narrow green ribbon from 1 to 10 miles wide, stretching a thousand miles across the brown and yellow desert, and ending in a fertile delta 150 miles broad. Thousands of years before civilized man lived in western Europe, the valley of the Nile was the seat of a powerful and enlightened empire, where lived a remarkable race of builders, engineers, and warriors. Their temples and pyramids have been the wonder of all ages. The Nile Valley was the cradle of one of the world's oldest civilizations. When we catch the first glimpse of the ancient Egyptians, 6000 years ago, they were even then far advanced.

Size and Character. — The Nile, second in length only to the Mississippi-Missouri, is over 4000 miles long. Rising almost on the equator in one of the great lakes of central Africa (Victoria Nyanza), fed by the heavy downpours of the belt of calms and of the Abyssinian monsoon, the Nile carries such a volume of water that it

flows 1600 miles across the Sahara without increase from a single tributary. Three great rivers combine to make the Egyptian Nile (Fig. 124), namely the *White Nile* from the equatorial lakes, the *Blue Nile,* and the *Atbara* from the mountains of Abyssinia. In the middle course of the river are six series of rapids called cataracts (Fig. 124), between which the river flows with a fall of less than an inch to the mile. The Nile Valley is narrow, rarely over 10 miles in width. The cultivated area, including the entire valley and delta, is about one-fifth that of Illinois (Fig. 125).

The Nile Floods. — Of such unusual importance to millions of people are the Nile floods that they deserve more than passing notice. In early summer the river is at its lowest. In June it begins to rise, and during August and September it spreads like a lake over its flood plain; in late September it is 20 feet above its low-water stage at Assuan; then, suddenly, it begins to fall, subsiding almost as rapidly as it rose. Year after year with wonderful regularity this is repeated. The Egyptians have kept accurate records for 3000 years, and these show the average annual rise at Thebes to have been 36 feet. Under the old system of irrigation (and to some extent even now) a difference of six or eight feet in the height of the flood water was a matter of serious importance. If the water rose too high, embankments broke and disaster followed. If it did not rise high enough to overflow the land, there was no crop, and famine followed. In 1877 nearly a million acres of land failed to receive water and there was great suffering among the people.

Cause of the Rise and Fall of the Nile. — It is a strange fact that neither of the large branches which join the main river in the stretch south of Khartum supplies any appreciable amount of water to the Nile floods. The flood waters and their load of rich silt do not come from these headwaters, but from the Blue Nile and the Atbara, which are fed from the torrential summer rains in Abyssinia. Such a volume of water does the Blue Nile pour into the main channel at Khartum that it actually obstructs the flow of the White Nile, temporarily ponding it back into a great lake. When the flood of the Blue Nile subsides, the White Nile is able again to

send its retarded waters on to Egypt. The supply of water from the lakes and swamps at the headwaters of the White Nile would naturally be quite constant, but this would give most of the valley no overflow, and without that there would be no fertile Egypt. Here is an impressive illustration of the importance of a single geographic influence in the making of a nation.

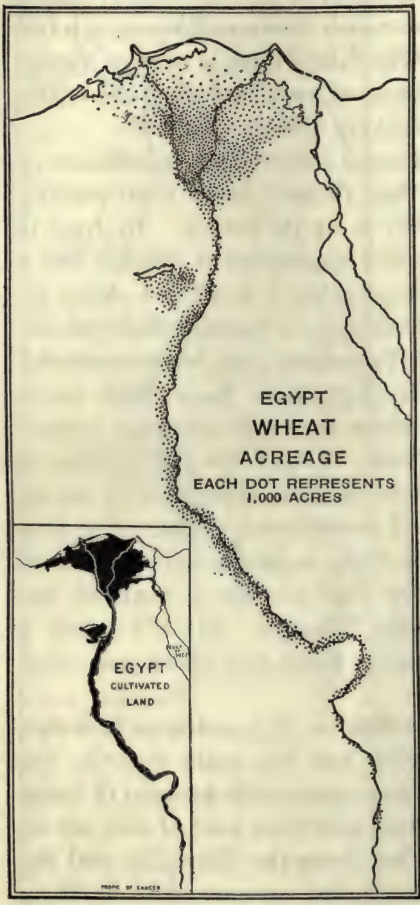


Fig. 125. — (*U. S. Dept. of Agr.*)

The Older Method of Irrigation. — For ages the Egyptians irrigated such land as they could by crude methods. Embankments or dikes were built inclosing shallow "basins" on the flood plain. When the river rose high enough, it filled the basins with the muddy Nile water, which stood in them for six weeks or more. The mud settled to the bottom, and the water soaked deeply into the soil. When the river subsided, the surplus water was allowed to drain from the basins back into the river, and as soon as possible seed was sown in the wet ground. This method had two objections: (1) only one crop a year could be secured; (2) only the land which was overflowed produced a crop, and the amount of such land varied according to the height of the river. Some additional land was irrigated by using crude pumps and water wheels oper-

ated by men or animals. Thousands of these are still in use, and travelers tell of the dreary groaning chorus of the pumps and wheels as they laboriously lift the water to the thirsty land.

The Present System of Irrigation. — Under the direction of the English engineers a great dam $1\frac{1}{4}$ miles long has been built across the Nile at Assuan near the first cataract (Fig. 124). Around the dam is a canal with four locks, enabling boats to pass. Through the dam are 180 openings with gates that can be opened and closed. By means of this dam the excess flood waters, which formerly flowed unused to the sea, are now stored in a great artificial lake that extends nearly 200 miles up the valley of the Nile. In the dry season this water is released, and is directed into canals and carried over the land, enabling the people to raise two or more crops a year.

Cotton of excellent quality is the most profitable crop, and Egypt ranks third in the world as a cotton-growing country; but corn, wheat, barley, and vegetables are also grown in large quantities. Much more ground is now irrigated than formerly, larger crops are grown, the population has nearly doubled, and the country is prospering as never before. Other important improvements now under way are directed towards the irrigation of still more land. So productive are the flood plain and delta of the Nile that, although the area under cultivation is only one-fifth of that of one of our medium-sized states, it supports 12,000,000 people. Portions of the delta have 1600 persons to the square mile, the densest agricultural population in the world.

The Nile as a Waterway. — Excepting at the rapids or "cataracts" the Nile is navigable for 2900 miles. It is still the main artery of traffic, although paralleled in part by a railroad. Swarms of the peculiar Nile boats, with their odd sails, and a considerable number of steamers navigate the river. The mouths of the river are practically useless for navigation because of sandbars and because of dams built to keep out the sea water and thus to preserve the fresh Nile water for irrigation. Cairo, once of great commercial importance, is at the apex of the delta, about 100 miles inland from the sea. Alexandria, the largest city in Africa, is on a spur of solid land at the mouth of one of the distributaries.

FIG. 126. — A barage, near one of the mouths of the Nile; by this means, the flow of water is regulated for purposes of irrigation. (*U. S. Bur. of Soils.*)

Man and Nature in Egypt. — The story of Egypt and the Nile illustrates two great principles in the field of geography. The complete dependence of 12,000,000 people upon a single, natural phenomenon, such as the annual rise of a river, shows the way in which men are sometimes under the domination of their geographic environment. The Nile floods irrigated a strip of desert and it early became the seat of an enlightened empire. The second principle is illustrated by the splendid engineering feat, the building of the Assuan dam and its related devices for controlling and utilizing the floods: an example of man's conquest of nature; of his power to subjugate the forces of nature and make them serve him.

The Ganges and India

Importance of the Ganges in the History of India. — Next to China, India is the most populous country in the world. Here, in an area half the size of the United States, are crowded together nearly twice as many people as live in the whole western hemisphere. India has been the home of mankind for thousands of years, and the people have crowded into every province in about as great numbers as the land will support. When we discover that nearly half of India's great population live in one-fifth of the coun-

try, we at once suspect that this one-fifth must be a remarkable region; and such it is, for its soil feeds nearly as many people as live in North and South America combined. This region is the valley of the Ganges River — not one of the long rivers of the world, for it is only half the length of the Missouri.

As one cannot think of Egypt without thinking of the Nile, so one cannot think of India apart from the Ganges. This river and its

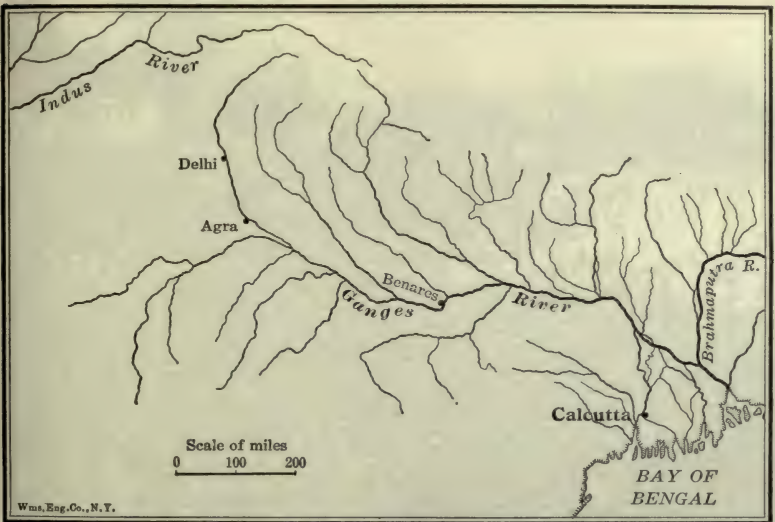


Fig. 127. — The Ganges River system. Note the preponderance of tributaries from the north.

broad flood plain have affected the history of India and the life of its people for centuries. The great civilizations of antiquity grew up on the rich flood plains of Egypt, of Mesopotamia, of India, and of China. The rivers which built these flood plains have entered intimately into the history, the literature, the religion, and the life of the people. The inhabitants depend mainly upon agriculture, and the river whose waters and enriching silt give them their crops soon comes to be almost a god.

As the ancient Egyptians worshiped the Nile, so millions of

Hindus worship the Ganges. Temples and shrines line its banks and hundreds of thousands of people yearly come to bathe in its sacred waters and thus, as they believe, to wash away their sins (Fig. 128). Benares, the most holy of their cities, has over a thousand temples and shrines. All this illustrates how a river

FIG. 128. — Thousands of pilgrims seeking an opportunity to bathe in the sacred waters of the Ganges. (*Physiography Lab. Cornell Univ.*)

that irrigates and fertilizes a people's lands may so enter into their affections that they regard it as sacred.

Features of the Valley. — The Ganges is fed by the perpetual snows of the Himalayas and by the heavy summer rains of its own valley. The rapid mountain streams which enter the Ganges from the north have brought down a great amount of gravel and finer sediment and have deposited it in the broad valley of the Ganges and Indus, partially filling it and crowding the Ganges southward

almost to the edge of the valley. This process must have gone on for a long time, for the valley is now filled to a depth of many hundreds of feet with the sediment. This is similar to the process by which the Great Valley of California has been filled. The Ganges

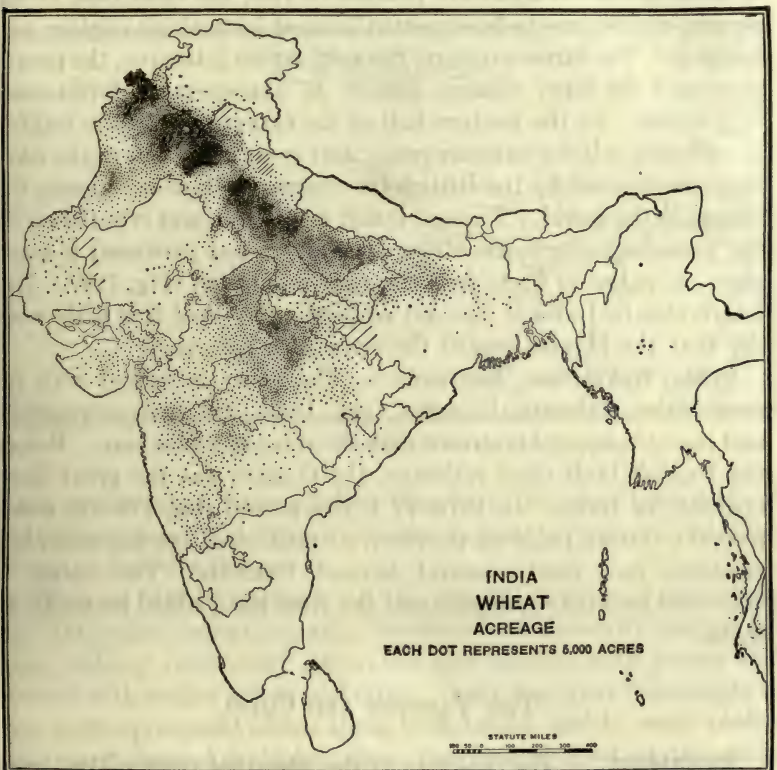


Fig. 129. — Wheat-growing regions of India. Note the concentration in the fertile valley of the upper Ganges. (*U. S. Dept. of Agr.*)

has thus built a broad and fertile plain, and with the aid of the Brahmaputra, which joins it from the east, is still engaged in extending its delta out into the sea. A low, swampy, tiger-infested jungle reaching 200 miles back from the mouth of the river covers

this rapidly extending delta. The principal distributary in the delta is the river Hooghly, on which the largest city of India, Calcutta, is situated.

Agriculture in the Ganges Flood Plain. — Hundreds of thousands of acres of the lowlands are planted to rice, the chief food of the people, and to jute to be exported or used for making cordage and bagging. The farms are tiny, the cultivation intensive, the people poor, and the farm villages almost as numerous as farmhouses in America. In the western half of the Ganges Valley the rainfall is sufficient only for summer crops, and great irrigation works have been constructed by the British Government; these are among the largest in the world. The soil is soft and warm, and is enriched by the periodical overflows. The amount of food produced is enormous, as it has to be to feed the vast population (Fig. 129). Nowhere else in India is the soil so productive, and it is little wonder that the Hindus regard the river with reverence.

Cities, Navigation, Railroads. — The valley is dotted with famous cities, Calcutta, Benares, Agra, Delhi (the present capital), and many more, and is strewn with the ruins of still others. Before the English built their railroads, the Ganges was the great thoroughfare of India. In 1876–77 it is reported that 178,000 boats passed a certain point on the river. Small boats are still used, but steamers now rarely ascend beyond Calcutta. The valley is traversed by many railroads and the river has yielded its traffic to them.

The Yangtze and China

Importance. — The Yangtze is the principal river of the most populous country in the world. As a highway of commerce it serves more people than any other river. It is as long as the Mississippi and carries a much greater volume of water. Rising at an altitude of over 10,000 feet in Tibet, the headwaters plunge down a succession of falls and rapids, acquiring great erosive power, and supplying an enormous load of rock waste to be carried out across the lowlands of China for building up the flood plain and delta of

the Yangtze (Fig. 130). Like the Ganges and the Amazon it is wearing away the mountains and building up the plains. This work of rivers has greatly increased the producing power of the earth, for alluvial plains supply a large proportion of the world's food. A quarter of the human race lives in China, and the larger

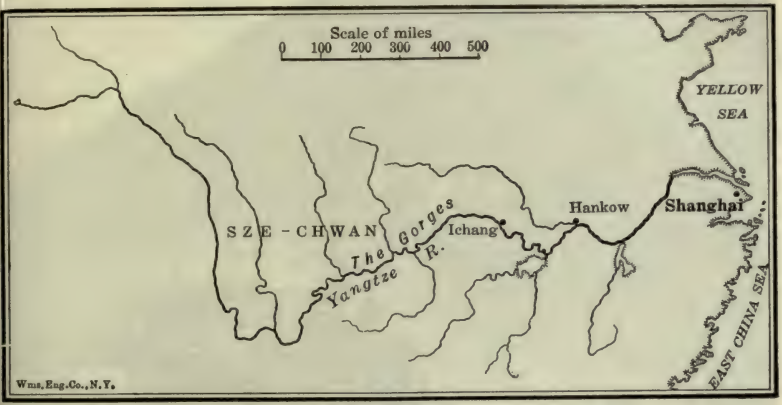


FIG. 130. — The Yangtze River system, China.

part of these are farmer folk tilling little pieces of alluvial land which has been laid down by China's many rivers, notably the Yangtze and the Hwang.

Features of the Yangtze. — At its mouth is a delta of great size; for 1000 miles above its mouth, the river flows through a plain of its own making, intensively cultivated and teeming with people and dotted with walled towns and cities. Like the lower Mississippi it has built up natural levees along both banks, and in many places the river channel is higher than the general level of the plain through which it flows. It will be recalled that this is common with silt-carrying rivers which periodically flood their valley bottoms.

At Ichang begin the picturesque gorges which the river has cut through the mountain ranges that here rise across its course (Fig. 131). These deep mountain gorges recur for 400 miles through the mountainous belt that separates the plains of eastern and central

China. In this 400-mile stretch there are said to be 13 important rapids and 72 minor ones. Beyond the gorges (west) lies Szechuan, the most productive and populous of the eighteen provinces of China. In this rich interior basin, as large as California, live

FIG. 131. — In the gorge of the upper Yangtze River in China. Type of boat used on this river.

from 40 to 50 million people, and the only commercial highway between it and the outer world is the Yangtze.

The Yangtze as a Highway of Commerce. — China has few railways and the navigable rivers are of utmost importance. Near the mouth of the Yangtze is Shanghai, the chief commercial city of China. Ocean steamships ascend the river 600 miles to the great city of Hankau (often called the Chicago of China), and large river steamers ascend to the rapids, which are navigable mainly by specially built Chinese junks and small boats. The junks carry

50 tons or more of freight. At high water the boats rapidly descend the rapids but the up journey is difficult and dangerous. The boats are laboriously hauled up the rapids by long lines of Chinese coolies, called "trackers" (Fig. 132). The largest boats require 200 to 300 men tugging at a bamboo rope a quarter of a mile

FIG. 132. — The peculiar Yangtze boats are hauled up the rapids by scores of Chinese called "trackers," pulling on a bamboo rope that is sometimes a quarter of a mile long.

long. Scores of men and boats are lost every year. The labor of the trackers is the most arduous in which any human beings regularly engage. For 12 hours a day they labor like draught horses, live on a little rice, and earn a mere pittance.

Eight thousand junks and a quarter of a million river men carry on the commerce of the upper Yangtze. In this way, most of the

merchandise and produce are conveyed in and out of interior China; and almost the sole avenue for a vast traffic is the Yangtze. No other river means so much to the commerce of a nation as this river means to China. The Yangtze is to be remembered as a type of great river serving as a nation's main artery of communication.

EXERCISE XII

1. Why are the rivers of the Atlantic slope of South America long while those of the Pacific slope are very short?
2. Why does the Amazon carry a great volume of water?
3. Why does its current flow rather slowly?
4. Why is the Amazon basin a jungle?
5. Why has the development of the Mississippi Valley been much more rapid than that of the Amazon?
6. Why is river navigation important on the Amazon but not on the Mississippi?
7. Why has the valley of the Rhine been for centuries one of the foremost trade routes of Europe?
8. Why is the Rhine more uniform in volume than many other rivers?
9. Why were the old castles located mainly along the "gorge" portion of the Rhine?
10. Why is the Rhine used more for navigation than any of our American rivers?
11. Why do coal, ore, grain, and other heavy commodities form the larger part of the Rhine traffic?
12. Why are rivers used more largely for navigation in Russia than in the United States?
13. Why is the Volga a slow-flowing river?
14. Why is its upstream traffic larger than its downstream?
15. Why is oil used as fuel by the Volga steamers?
16. Why has the Nile no tributaries in its lower course?
17. Why is the Nile of exceptional importance to Egypt?
18. Why does the river rise to such a great height at times of flood?
19. Why is the White Nile of less importance than the Blue Nile?
20. Why was the great dam of Assuan built?
21. Why is the present system of irrigation in the Nile Valley superior to the old system?
22. Why is the Nile flood plain and delta able to support a very large population?
23. Why is the Ganges Valley the most important part of India?
24. Why do the Hindus regard the Ganges as a sacred river?
25. Why does the Ganges receive the larger part of its water and silt from the northern tributaries?
26. Why does the Ganges Valley contain so large a part of the population of India?

27. Why is the Yangtze of great value to the people of China?
28. Why is human labor very cheap in China?
29. Why is the plain of the Yangtze very fertile?
30. Why is this river building a delta at its mouth?

The following places and geographical features are mentioned in the foregoing chapter: what and where is each? Manaos, Nizhni Novgorod, Constance, Benares, Bonn, Moselle, Hooghly, Hankau, Iquitos, Caspian, Mainz, Madeira, Atbara, Para, Agra, Cairo, Hwang, Calcutta, Rotterdam, Alexandria, Delhi, Astrakhan, Assuan, Indus, Cologne, Venice, Himalaya, Peru, Strassburg, Antwerp, Genoa, Elbe, Danube, Seine, Shanghai.

CHAPTER X

GLACIERS PRESENT AND PAST

The Glaciers of the Alps

Origin and Movement. — The peaks of the Alps are between two and three miles high and at this altitude the snow does not entirely melt during the summer; each succeeding winter more is added until the piled-up snow in the *snow fields* becomes deep and heavy. So great is the weight that the snow and ice move slowly down the high mountain valleys in tongues of ice known as *mountain glaciers* or *valley glaciers;* of these there are nearly 2000 in the Alps alone (Fig. 133). Their motion is like slow flowage, and the rate of movement varies from a few inches to a few feet daily. They flow somewhat more rapidly at the top and middle than at the bottom and sides, where they are retarded by friction. Part way down the valley the end of the tongue of ice gradually melts and feeds some mountain stream. The constant melting of the glaciers during the summer tends to keep glacier-fed rivers more steady in their flow than other rivers. The longest glaciers of the Alps are from 5 to 10 miles in length, but most of them are much shorter. In places they are crossed by great open cracks and chasms called *crevasses,* into which stones fall and become eroding tools at the bottom of the ice.

Erosion and Transportation. — In the high mountains avalanches frequently plunge down the mountain sides, tearing away loose rock and carrying it down upon the snow fields or glaciers. Fragments of rock, large and small, slide and roll down the mountain slopes and are carried along by the moving ice. Valleys in which glaciers have worked for a long time become worn into U-shaped troughs (Fig. 137). Many such troughs are found

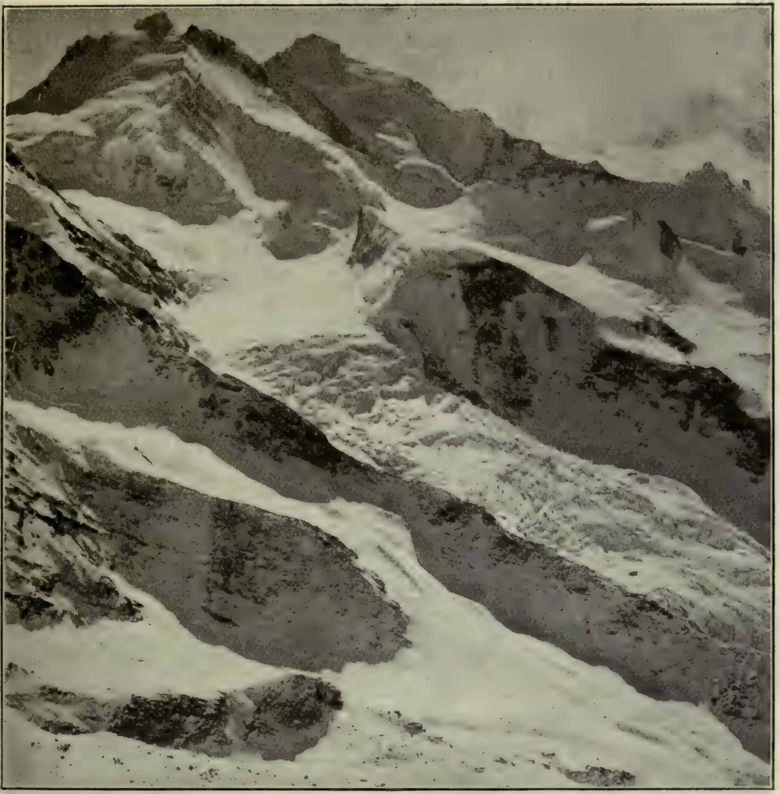


FIG. 133. — Scene in the high Alps where glaciers are forming. (*Aëroplane photo by Swiss Aviation Service.*)

FIG. 134. — An Alaskan glacier. Note the dark bands of medial moraine extending lengthwise of the glacier. (*Martin.*)

FIG. 135. — The black areas represent the largest glaciers of the Alps; these are superposed upon the Hubbard glacier of Alaska, drawn to the same scale. (*After Martin.*)

where no glaciers now exist and they tell unmistakably of a period when glaciers occupied these valleys.

Terminal Moraines. — As the lower end of the glacier melts, the earth, gravel, stones, and bowlders, mixed in the ice, pile up around the end forming what is known as a *terminal moraine*. Similar deposits along the sides of glaciers are *lateral moraines*.

Scenery as a Natural Resource. — The glaciers of the Alps attract thousands of

FIG. 136. — A V-shaped valley made by stream erosion. Compare with the glaciated, U-shaped valley shown in Fig. 137. (*U. S. Geol. Sur.*)

visitors every year. Excellent carriage and automobile roads have been constructed, and at sightly points hotels have been built. The Alps and their glaciers thus bring millions of dollars to the

FIG. 137. — A mountain valley that has been eroded into a U-shape by valley glaciers. (*U. S. Geol. Sur.*)

mountain people every summer. In fact, the scenery of Switzerland must be counted as one of the little country's chief resources.

EXISTING GLACIERS IN NORTH AMERICA

Alaska. — On the Pacific slope of the Alaskan mountains the snowfall is very heavy, and great numbers of glaciers exist; these are much larger than the glaciers of the Alps. Hubbard Glacier is 40 miles long and 3 miles wide at its terminus. In Fig. 135 three of the largest Swiss glaciers are compared in size with one of the large Alaskan glaciers, and in Fig. 139 the front of a glacier is shown in comparison with the height of the National Capitol at Washington.

Tidal Glaciers and Icebergs. — Many of the glaciers of Alaska and Greenland reach down to the sea, where great masses break off and float away as icebergs. Such glaciers are known as *tidal*

Fig. 138. — An Alpine glacier formed by the union of tributary glaciers. (*Aëroplane photo by Swiss Aviation Service.*)

glaciers (Fig. 140). Since ice is nearly as heavy as water, icebergs float with about seven-eighths of their mass below the water and so are very deceptive in appearance. Bergs of enormous size drift southward near Newfoundland and are a menace to Atlantic

FIG. 139. — Front of the Childs Glacier, Alaska, with the Capitol at Washington drawn to the same scale. (*Martin.*)

FIG. 140. — A tidal glacier in Alaska. The ice slowly advances into the bay until it reaches water that is deep enough to float the ice, and then large blocks break off and float away as icebergs. (*Martin.*)

steamers (Fig. 141). The great Atlantic liner *Titanic* struck such a berg in 1912 and sank within a few minutes.

Piedmont Glaciers; the Malaspina. — In certain regions such as Alaska, several mountain glaciers, flowing down neighboring valleys, sometimes unite at the base of the mountains into a broad, low plateau of ice. The Malaspina Glacier in Alaska is such a glacier (Fig. 142); it has an area of 1500 square miles, which is more

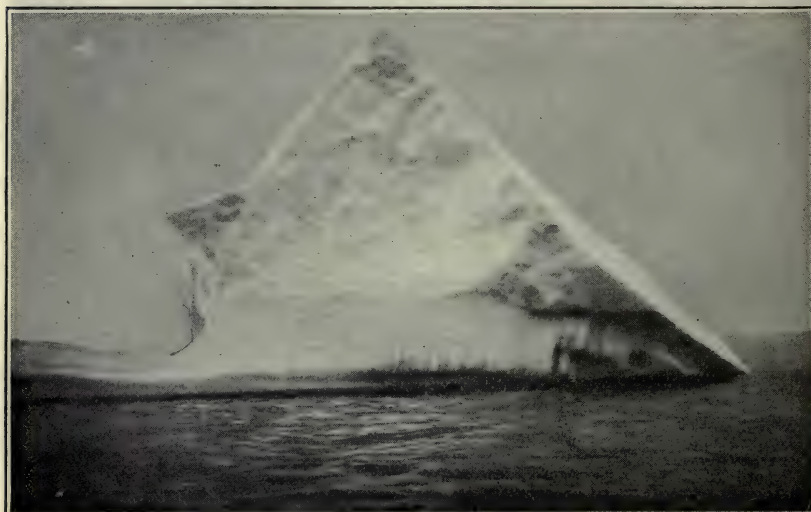


Fig. 141. — An iceberg from the north floating southward near Newfoundland. These enormous icebergs constitute a menace to shipping in these waters. (*U. S. Geol. Sur.*)

than that of Rhode Island. This glacier remained stationary for a time; the surface ice melted during the summers and gradually the glacier became covered with soil; trees and shrubs took root, and a forest 20 to 35 square miles in area grew on the surface of the glacier.

The Greenland Ice Cap. — Greenland is four times the size of France; with the exception of a narrow border near the coast, it is entirely covered by snow and ice, the accumulation of centuries. This plateau of ice has a very slow movement from the middle outward toward the sea; some distance back from the shore the ice

collects in valleys that fringe the coast and moves down to the sea in the form of valley glaciers. These valleys end in deep bays or *fiords* where the ice breaks off and floats away as icebergs. It is

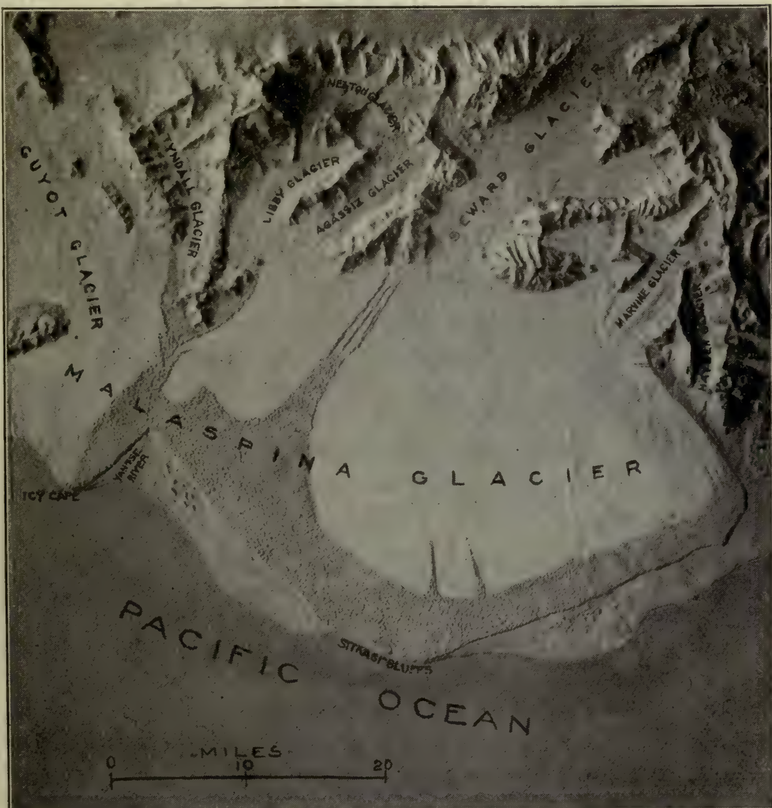


Fig. 142. — Photograph of a model of Malaspina Glacier on the coast of Alaska. *(Model by Martin and Lorenz.)*

known that the fiords themselves are mainly due to prolonged erosion by the tongues of glacial ice.

Other Glaciers in North America. — Glaciers occur in the Canadian Rockies, and still smaller ones in Glacier National Park

in Montana, and on high peaks in the Cascade Range, and even in Mexico.

Glaciers in Other Parts of the World. — There are many valley glaciers in the southern Andes, and also a few small ones near the equator in the Andes and in Africa. There are also glaciers in the Caucasus and Himalaya mountains, in Norway and New Zealand, and in islands of the Arctic Ocean. The continent of Antarctica is covered by the largest ice cap now existing. It is more extensive than Europe, and resembles the Greenland ice cap, but is much larger.

Valley Glaciers Once Larger and More Numerous Than Now. — In the Alps, the Caucasus, the Rockies, and elsewhere, glaciers once occupied valleys where there are at present no glaciers, and existing glaciers reached many miles farther down their valleys than they do now. This is known by the moraines which they built and which are now conspicuous features of the valleys where glaciers have been. This and other facts show that valley glaciers in many parts of the world are shrinking, and this would seem to indicate either that the earth's climate on the whole is slowly becoming warmer, or that less snow is falling than formerly.

Continental Glaciers of the Past

Evidences That Glaciers of Great Size Have Existed in North America and Europe ; Lessons from the Alps. — The glaciers of the Alps have been studied for more than a century. Their movement, their power to erode and to carry rock débris, and their habit of depositing moraines have long been understood. It was noted that the moraines contained various kinds of bowlders and rock fragments brought by the ice from higher portions of the mountains. The rock sides and bottoms of valleys in which glaciers had moved were seen to be eroded, and even polished, by the moving ice. Such surfaces are marked by parallel scratches (called *striæ*) and even by deep grooves running in the direction that the ice moved (Fig. 143), and pebbles in the moraines are often worn and striated (Fig. 144). In short, European geologists had become familiar

with the signs of former glaciers at the base of the Alps long before they suspected that ice sheets had spread over a third of Europe and nearly half of North America.

Discovery of Glacial Evidences in the United States. — About 1850 the Swiss naturalist, Louis Agassiz (ăg′ă-see), who had come to the United States, noticed here bowlders, moraines, and striæ that looked like those left by glaciers in the Alps. He announced his belief that there had sometime been glaciers in parts of the

FIG. 143. — Rock surface polished and grooved by glacial erosion. (*U. S. Geol. Sur.*)

United States. Many scientists could not believe it, and fanciful theories were invented to account for these bowlders and moraines. But every year more evidence was discovered, all leading unmistakably to the conclusion that a great continental ice sheet must have once spread over Canada and the northern United States.

Nature of These Evidences. *Glacial Bowlders or Erratics.* — In most parts of our northeastern and north central states one may find bowlders of many different kinds of rock, some of which are entirely unlike the bed rock found in the region; they are called *erratics,* meaning *wanderers.* Sometimes they are of enormous

size (Fig. 145). In parts of New England they are so numerous as to interfere seriously with farming, while in parts of Illinois scarcely one can be found. In some instances these bowlders have been traced back to rock-ledges from which they were plucked by the glacier, these ledges being at times hundreds of miles to the north or northeast.

FIG. 144. — Glacial bowlder, showing a polished and striated face due to glacial erosion. (*U. S. Geol. Sur.*)

Striæ.—Frequently when a covering of earth is removed, the surface of the underlying rock is found to be marked by parallel scratches and grooves, showing that glaciers have moved over them and also showing the direction of their movement (Fig. 143).

Moraines. — When detailed maps of our northern states were made, ranges of hills, composed of sand, gravel, clay, and bowlders, were found to extend for miles across the country. These proved to be terminal moraines, built up of materials brought by glaciers and deposited when the ice melted. One may see this taking place now in the Alps or in Alaska on a smaller scale. These and other evidences carefully studied for a half century so completely prove the former existence of a great continental ice sheet in North America that we are as sure of the fact as if we had actually seen the glacier itself.

Extent of the North American Ice Sheet. — During the Glacial Period or Ice Age, this continental glacier spread outward from two principal centers, one in Labrador and one west of Hudson Bay (Fig. 146). It appears that at these places the greatest amount of

FIG. 145. — A glacial bowlder of large size left by the glacier in northern New Jersey. (*Salisbury.*)

snow accumulated, reaching a depth of thousands of feet. The weight or pressure became so great that, as in Greenland at present, the whole body of snow took on a slow movement, mainly toward the south, and was not stopped until it reached a region where the southern climate melted it. At the same time that the great depth of snow was collecting at these centers, valley glaciers were forming in all of the higher mountains of the northern half of the continent. The glacial ice pushed as far south as Pennsylvania, the Ohio River, and the Missouri River, covering the highest peaks of the Adirondacks and the New England mountains. In southwestern Wisconsin, extending a little into Minnesota, Iowa, and Illinois, there is an area of about 15,000 square miles which, for some reason, was not covered by the glacier; it is known as the Driftless Area (Figs. 146a and 146b).

The European Ice Sheet. — Another continental glacier spread southward from the north of Europe as far as central Russia, central Germany, and southern England (Fig. 147).

FIG. 146a. — A map showing the centers from which the glacial ice moved in the last glacial period, and the maximum extension of the ice sheet. (*After Tarr and Martin.*)

Fig. 146b. — The white area in the northeast represents the southern portion of the ice sheet of the last glacial epoch (the Wisconsin). The dark area reaching somewhat farther southward represents the more advanced position of the ice sheet in earlier glacial epochs. (*Photo and Model by Howell, Wash., D. C.*)

Fig. 147. — Extent of glaciation in Europe.

Changes Made by Continental Glaciers

Erosion. — The slowly moving ice plowed its way over hills and mountains, through valleys and over plains. Loose rocks and soil became mixed with the ice and were also carried along. Projecting ledges of rock were plucked and worn away; hill-tops and mountain-tops were partially rounded off, and some valleys were considerably eroded (Fig. 137). The large features of the land, however, such as the highest hills, the mountains, and the main valleys, were changed only in minor details.

Glacial Deposits

Glacial Drift. — In parts of Canada and New England the glaciers scraped off much of the soil and carried it southward, causing serious loss to these regions; but the area south of the Great Lakes, and other regions where there was deposition rather than removal, received large deposits of *glacial drift*, as the ice-carried

FIG. 148. — The hummocky hills of a terminal moraine in Illinois. (*U. S. Bur. of Soils.*)

débris is called. In some places former valleys were entirely filled and streams were compelled to find new courses.

Terminal moraines were heaped up along the margin of the ice, marking places where the front of the glacier stood for a considerable time, melting along the front as fast as the ice moved up from behind (Fig. 148). As the ice melted it dropped the rock and earth which it carried, and in the course of time built up morainic hills, often a hundred feet or more in height, in belts several miles wide, and extending for scores or even hundreds of miles in length (Fig. 148).

The front of the glacier was a series of lobes which projected forward in the valleys and lowlands. We can now tell where the ice lobes were by the great loops of moraine which mark their former positions (Fig. 149). Each terminal moraine marks a place where the front of the glacier stood for a long time during its intermittent retreat toward the north at the close of the Ice Age.

The Ground Moraine. — At other times the front of the glacier melted or receded rather steadily, pausing nowhere long enough

to heap up terminal moraines; instead, the glacial drift laid down by the melting ice was spread somewhat unevenly over the surface in what is called a *till sheet* or *ground moraine* (Fig. 150). In places this is only a few inches or a few feet deep, but may be all the way up to a few hundred feet deep, as in the states from Ohio westward to the Missouri River; these glacial plains are one cause of the agricultural excellence of the north central states.

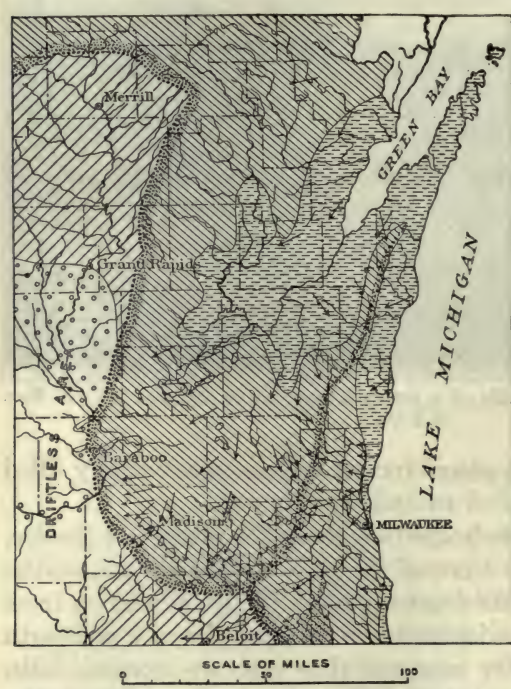


FIG. 149. — Map showing the position of one of the lobes of the glacier that invaded Wisconsin. The arrows indicate the direction of the movement of the glacial ice. (*Alden, U. S. Geol. Sur.*)

Outwash Plains. — As the glacier, with its included load of rock waste, melted, it yielded a great amount of water which flowed away from the ice, and, where the land sloped away from the glacier, built *outwash plains*. These differ from ground moraine in being made of water-sorted material (sand, clay, and gravel) roughly stratified and nearly level. The total area covered by outwash plains in the United States amounts to many thousands of square miles.

Streams Obstructed. — Both the terminal moraine and the ground moraine seriously obstructed the former courses of streams. In some cases rivers were forced to reverse the direction of their flow; in others they were forced to wind in and out among the morainic hills in entirely new courses, giving rise to rapids and falls.

Lakes Due to Glaciers. — The heaps of moraine dumped in the valleys by the glaciers act as dams; the streams are thus obstructed, and lakes are produced (Fig. 151). This is the commonest cause of lakes, and in most regions where glaciers have existed, lakes are numerous. The beautiful lakes of Switzerland, Scotland, and England are mainly due to glaciers. There are many thousands of these in Finland, Sweden, and Canada; New England is dotted

FIG. 150. — Type of gently rolling ground moraine in southern Wisconsin; excellent farm land. (*U. S. Bur. of Soils.*)

with them. The beautiful lakes of New York, New Jersey, Wisconsin, and Minnesota are of the same origin. Some of these bodies of water occupy rock basins which were eroded or scoured out by the glacier, but a much greater number are due to the damming of streams by moraines.

The Great Lakes. — The five Great Lakes, lying along the Canadian border, are due to glacial work. They occupy old river basins which have been eroded and deepened by the ice lobes that

moved through them, while masses of moraine form low dams across the basins.

Swamps. — The obstruction of streams by glacial deposits also caused many swamps or marshes. These are more or less numerous over the entire glaciated area, and in all cover millions of acres. Many of the shallowest glacial lakes have become filled with sediment and vegetation and now are merely swamps.

Fig. 151. — Hundreds of glacial lakes in northern Wisconsin. (*Wis. Geol. Sur.*)

The Value of Lakes. — The lakes of our northern states are a large asset. Their shores are delightful places for homes, summer cottages and hotels, and sanitariums. They attract ever increasing numbers of people who seek rest and enjoyment and who bring into the region a large sum of money. As sources of ice, fish, and water for cities these lakes have an annual value of millions of dollars. Our chain of Great Lakes, forming the greatest inland water way in the world, has already been discussed in Chapter VIII.

Waterfalls. — It is safe to say that nine-tenths of the waterfalls in the glaciated area of the United States would not exist if glaciers had not interfered with the former courses of the streams. Glacial drift fills or partly fills many of the preglacial valleys, and streams are forced to flow in new and ungraded channels. Here and there these streams plunge over rock-ledges, and waterfalls are produced. At such places, water power is available and leads to important industries. Niagara Falls, the falls at Minneapolis, at Rochester, N. Y., at Paterson, N. J., and at hundreds of other

places in New England, New York, Wisconsin, and elsewhere, are due to changes caused by glaciers.

Glacial Soil. — In much of New England and eastern Canada the glacier removed the original soil and left large areas strewn with bowlders; in general this proved an injury to agriculture. But in the upper Mississippi Valley the wide stretches of glacial plains form one of the garden spots of the earth. Investigations in the states of Wisconsin, Illinois, and Ohio lead to the belief that agriculture in these states benefits yearly to the extent of millions of dollars through the smoothing of the topography due to glacial deposits (Fig. 150).

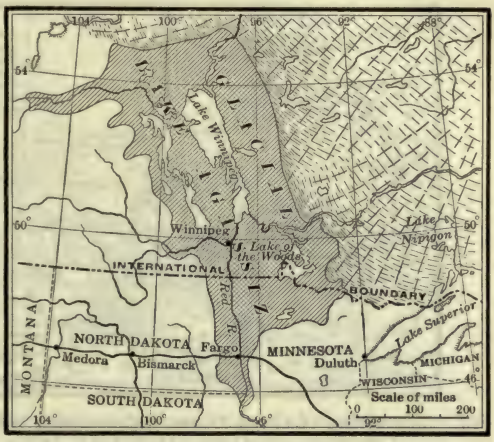


FIG. 152. — Map showing part of the glacial ice sheet as it was melting away at the close of the Glacial Period. The front of the ice formed a dam that produced a lake of great size (Lake Agassiz) which had its outlet southward through the Minnesota River. Lake Winnipeg is a remnant of that glacial lake. (*U. S. Geol. Sur.*)

Temporary Lakes of the Glacial Period. — A portion of Minnesota and the Dakotas and most of central Canada slopes toward the north, and the rivers flow in that general direction. Since the glaciers came from the north and northeast, and melted back from the south toward the north, the ice formed temporary dams in the valleys of these north-flowing rivers and thus lakes were formed. One of the largest of these, known as *Lake Agassiz*, covered an area greater than that covered by all of the five Great Lakes together (Fig. 152). It occupied the valley of the Red River of the North, and while it lasted, drained southward through the Minnesota River into the Mississippi. When the ice dam had melted away, the lake drained northward into Hudson Bay and

shrank to what is now Lake Winnipeg in Manitoba. The fine silt which this lake deposited over its bed now constitutes very rich soil over an almost perfectly level plain.

Various Stages of the Great Lakes. — When the glacial lobes were slowly melting from the basins now occupied by the Great

FIG. 153. — Map of Great Lakes region during the retreat of the glacier. Note the various outlets of the lakes. (*After Taylor and Leverett.*)

Lakes, marginal lakes of varying sizes occupied the southern and western portions of the lake basins. In an early stage each of these marginal lakes had its own outlet into the Mississippi (Fig. 153). At a much later stage (Fig. 154) they drained eastward by way of the Mohawk-Hudson Valley. Between these stages many different outlets were used.

Epochs of the Glacial Period. — Careful study of glacial deposits shows that the last Ice Age had several epochs of cold climate alternating with epochs of warm climate; during the latter the ice-front withdrew toward the north and remained for many thousands of years. These warmer epochs are referred to as *interglacial periods.* It is possible that we are now living in an interglacial period, and that thousands of years hence our northern states may again be buried beneath a great ice sheet.

Very Ancient Glacial Periods. — The Glacial Period of which we have been speaking occurred in a recent geological age. It is often

spoken of as having occurred but yesterday. This was only one of many glacial periods that have come and gone during the long ages of the past. Glacial bowlders, glacial striæ, and consolidated glacial drift are found in rocks of great age in Brazil, South Africa, India, Australia, Canada, Scandinavia, and elsewhere. It is clear

FIG. 154. — Map of the Great Lakes region at a later stage than that shown in Fig. 153. Compare the outlets of the lakes in the two maps. (*After Taylor and Leverett.*)

that the climate of the earth undergoes great changes and that glacial periods have occurred time after time throughout the past.

SUMMARY

Glaciers occur wherever the amount of snow which falls each year in the mountains is greater than the amount which melts. In these regions snow accumulates and is compressed into ice, which flows slowly down the mountain valleys. The rate of flow is usually a few inches or, at the most, a few feet a day. Loose rocks fall upon the glaciers or are plucked from ledges along the route, and some of these rocks, firmly frozen in the bottom of the glacier, act as tools for eroding the valley down which the ice is moving. Where the ice melts terminal moraines are built.

There are hundreds of valley glaciers, mostly small ones, in the

Alps. Alaska has still more and larger valley glaciers, many of which move down to the bays and fiords and break off to form icebergs. The fiords of Alaska, Norway, and other regions are mainly due to prolonged glacial erosion. Nearly all of the lofty mountain ranges, even in the tropics, have valley glaciers. Greenland and the Antarctic Continent have slowly moving ice caps covering almost their entire surface.

During the last 60 or 70 years complete proof of the presence of former glaciers of great size in North America and Europe has been established through the evidences of glacial striæ, erratics, moraines, etc. The European ice sheet, with its principal center in Scandinavia, reached as far south as southern England, Germany, and central Russia. In North America the principal centers from which the glaciers moved were in Labrador and in Canada just west of Hudson Bay. The ice sheet extended as far south as New Jersey and Pennsylvania, the Ohio River, and the Missouri River. In places the glaciers eroded the land considerably, carrying away the soil, rounding off the tops of hills and mountains, and deepening valleys. In our north central states a great amount of glacial drift was deposited in the form of terminal and ground moraines and glacial outwash. South of the Great Lakes the drift is scores and even hundreds of feet deep in places. The glacial deposits have greatly interfered with the courses of streams, causing lakes, swamps, rapids, and falls. The glacial plains of the north central states are among our finest agricultural lands.

Temporary lakes occurred in places along the southern border of the retreating ice sheet; one of these, Lake Agassiz, as large as all the Great Lakes together, occupied the basin of the Red River of the North. There were alternating periods of advance and retreat of the ice front, giving several glacial and interglacial epochs, each thousands of years long. The last glacial period came to a close in a recent geological age, perhaps not over 30,000 years ago. It was one of many such periods which have occurred at intervals during the history of the earth.

EXERCISE XIII

Explain the meaning of each of the following terms:

1. Snow field
2. Valley glacier
3. Terminal moraine
4. Crevasse
5. Tidal glacier
6. Piedmont glacier
7. Ice cap
8. Glacial erosion
9. Continental glacier
10. Striæ
11. Erratics
12. Glacial Period
13. Glacial drift
14. Ground moraine
15. Outwash plain
16. Preglacial
17. Interglacial
18. Postglacial
19. Ice Age
20. Glacial till

EXERCISE XIV

1. How are glacial striæ made?
2. How are terminal moraines built?
3. How did the continental glacier bring lakes into existence?
4. How did the continental glacier benefit parts of North America?
5. How did it injure other parts?
6. How did it cause waterfalls and rapids?
7. How did it cause swamps?
8. How are outwash plains formed?
9. How fast do glaciers move?
10. How do we know that there have been several ice ages in the past?
11. How was glacial Lake Agassiz caused? Where was it? How large?
12. How has Lake Agassiz proved a benefit to the territory that it covered?
13. How are most icebergs formed?
14. How did the Glacial Period benefit (*a*) present day agriculture? (*b*) present day manufacturing?

EXERCISE XV

1. Why do glaciers exist in some mountains but not in others?
2. Why do the glaciers of the Alps move faster in summer than in winter?
3. Why are glacier-fed rivers more uniform in their flow than most other rivers?
4. Why does glacial ice usually contain more or less rock waste?
5. Why do glaciated regions usually have a variety of soils?
6. Why does Alaska have more glaciers than British Columbia or Washington?
7. Why do the glaciers of Alaska extend down the mountain valleys to lower levels than those of the Alps?
8. Why is the Greenland glacier called an ice cap?
9. Why may glaciers exist even in the torrid zone?

10. Why do we believe that the climate of the earth as a whole is growing warmer rather than cooler?

11. Why did Agassiz decide that glaciers had covered portions of North America which now have no glaciers?

12. Why are there more lakes in glaciated regions than elsewhere?

13. Why are falls and rapids numerous in the rivers of glaciated regions?

14. Why did the continental glaciers of Europe and North America move for the most part in a southerly direction?

15. Why may the scenery of Switzerland be considered one of the natural resources of that country?

CHAPTER XI

SURFACE CHANGES PRODUCED FROM WITHIN

The Continents and the Ocean Basins. — The continents are large masses of the earth's crust which rise above the level of the sea, yet none of the continents is *wholly* above sea level. All of them have borders, called *continental shelves,* which are covered by shallow ocean water; thus the continents are larger than they appear on the map. At the seaward edge of the continental shelves the ocean floor slopes downward somewhat abruptly to the ocean depths. The ocean basins are believed to be portions of the crust that have settled; in sinking they have pressed with great force against the margins of the continents, forcing up portions of the crust to form mountains and plateaus.

Observed Movements of the Earth's Crust. — Most of the upward or downward movements of the earth's crust are very slow, but in some instances the change of level is rapid; for example, in an Alaskan earthquake (in 1899) a portion of the coast rose 47 feet, while a near-by portion settled several feet. There are abundant records of slower movements; for example, in northern Sweden, in the Bay of Naples, and in the island of Crete in the Mediterranean. On the coasts of Labrador, of California, of Peru, and in many other places, old shore lines are now scores or hundreds of feet above the present sea level. So common is this rising or sinking that almost every coast bears evidence of it.

Condition of the Earth's Interior. — Volcanoes, geysers, and hot springs show that below the crust of the earth, in certain places, at least, there is great heat. Well-borings and deep mines reveal an *average* increase of heat of 1° F. for each 50 or 60 feet of descent. Not long ago people believed the interior of the earth to be composed of molten or liquefied rock. Although the deep-seated rocks

are very hot, recent investigations prove that the interior of the earth is solid and is more rigid than a globe of steel; nevertheless, there are places where the rocks are melted and come to the surface as lava.

Earthquakes

Earthquakes Very Common. — If every earthquake were known and reported, we should find that they are of almost constant occurrence at one place or another. It is estimated that an average of nearly 100 earthquakes, which would be perceptible to our senses, occur daily. Most of these, and many still weaker tremors, are known only through the records made by instruments which auto-

Fig. 155. — Ruins of the gymnasium of Stanford University after the earthquake of 1906. (*U. S. Geol. Sur.*)

matically record even slight movements of the crust. Occasionally there are shocks of great violence, and when the latter occur in the neighborhood of cities, heavy loss of property and life results. Such earthquakes are among nature's most frightful phenomena.

Examples of Destructive Earthquakes. — San Francisco had an earthquake in 1906, which in itself did serious damage (Figs. 155, 156). The loss from fire was, however, still greater, for the broken water mains prevented the effective fighting of fire, which gained such headway that it destroyed about 25,000 buildings. The Charleston earthquake of 1886 is thus described: "Strange noises were heard and slight tremors were felt before the earthquake, notably on August 27 and 28. Just before ten o'clock at night on the 31st a rumbling sound was heard, increasing to a great roar, and the shaking became violent. There was a second violent shock a few minutes afterwards, and a number of aftershocks of lesser violence. The earthquake wave spread at the rate of 150 miles a minute, and was felt in many states; 14,000 chimneys were thrown down and 27 persons were killed." The terrible Lisbon earthquake of 1755 is reported to have caused the death of 60,000 people in six minutes. Southern Italy has had repeated earthquakes of terrible destructiveness; the one at Messina in 1908 caused the loss of 100,000 lives. Japan is subject to daily earthquakes, having

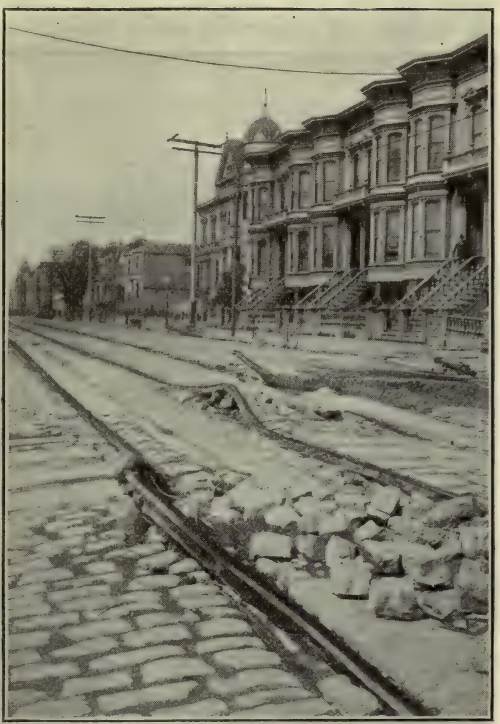


FIG. 156. — Effect of an earthquake upon the rails and paving of a city street. (*U. S. Geol. Sur.*)

an average of 1400 recorded tremors and shocks a year; most of them are light, yet 223 very destructive shocks are known to have occurred in that country in the last 1500 years.

Causes of Earthquakes. — The earth is still in the making; because of the slow contraction due to the loss of heat and other

FIG. 157. — The fence — formerly continuous — was offset 8½ feet by the California earthquake of 1906. (*U. S. Geol. Sur.*)

causes, the rocks of the earth's surface are constantly under great stress, so great that at times they break along some plane of weakness and one side is forced violently up or down or sidewise (Fig. 157). The displacement varies in amount from a few inches to many feet, and may occur along a line scores of miles in length.

This breaking of the rocks under stress is the chief cause of earthquakes, but there are minor causes of small importance, such as avalanches, the falling in of the roofs of caves, and the discharge of explosives.

Movement of Earthquake Waves. — Owing to the great pressure upon the deep-seated rocks, only those rocks near the surface are able to break and slip, and thus to produce a tremor or quake. At great depths the rocks flow rather than fracture. Directly over the line along which the fracturing of rock occurs, the shock sets up "waves," or vibrations in the earth's crust, and these have a nearly up-and-down movement which is very destructive, but as the waves spread outward from the place of origin, they become less and less dangerous. The waves thus started pass both around the earth and through it, accomplishing the latter in about 20 minutes. The great velocity with which these waves travel through the earth is one of the evidences that the earth's interior is solid.

Fig. 158. — Fissures in the earth opened by the California earthquake of 1906. (*U. S. Geol. Sur.*)

The Principal Earthquake Zones. — Both earthquakes and volcanoes are most common in regions of young, growing mountains, where rock stresses are great. Such mountains nearly encircle the Pacific Ocean. The Mediterranean Sea and the East and West Indies are also regions of frequent earthquakes (Fig. 165).

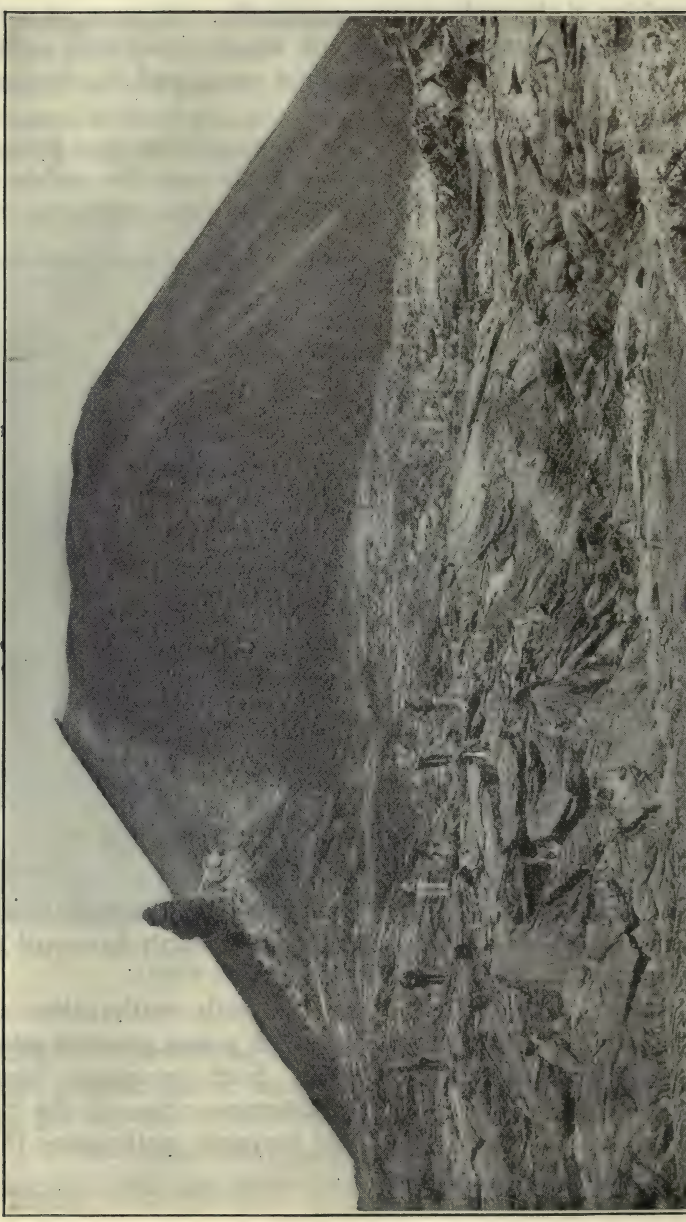


Fig. 159. — Ropy lava and cinder cone at the summit of Mt. Vesuvius, 1872.

Summary

Earthquakes occur at frequent intervals somewhere in the earth, but most of them do little harm; occasionally one of unusual violence occurs near a city and causes great loss of property and life. Earthquake waves travel very rapidly, passing through the earth in about 20 minutes. Japan has an average of 1400 recorded quakes a year, but most of them are of slight force. Earthquake shocks and tremors are due chiefly to fracturing and slipping of bodies of rock at or near the surface of the earth, and are most frequent in regions of young, growing mountains such as those which nearly encircle the Pacific Ocean, or those in the south of Europe, in the East Indies, and in the West Indies.

Volcanoes

Two Types of Volcanoes. — In the *quiet* type of volcanoes, such as those of the Hawaiian Islands, lava rises in the throat of the crater and from time to time spills over the rim or breaks through the side and flows slowly away in a thick, sluggish stream, cooling as it flows (Fig. 159). Volcanic cones built up in this way are broad in proportion to their height.

In the *explosive* type, the volcano may slumber for a long time, perhaps for centuries as in the case of Vesuvius; then rumblings are heard, steam issues from the crater, and soon a terrific explosion occurs. Steam, ash, cinders, and pieces of volcanic rock are hurled into the air and fall in a shower upon the surrounding country (Fig. 159). This explosion is usually, though not always, followed by the outpouring of lava. Sometimes clouds of suffocating gases pour from the crater and settle over the surrounding country, destroying every living thing. In the eruption of Mt. Pelée on the border of the Caribbean Sea (1902) every person, except one, in the near-by city of St. Pierre was killed.

Famous Volcanoes. — Of the 400 to 500 active volcanoes on the earth a few have become famous. Vesuvius (Fig. 160), by the Bay of Naples, has had several outbursts of great violence, one of them

burying the fine old Roman cities of Pompeii and Herculaneum in the year 79 A.D. Etna on the island of Sicily near Italy, and Stromboli near by, are also historic volcanoes. Krakatoa, on an island southeast of Asia, had (in 1883) one of the most terrific explosions ever known; windows were broken a hundred miles away; half of the island was hurled into the air, and water 1000 feet deep now occupies the place where this half of the island was. The

FIG. 160. — Mt. Vesuvius in eruption in 1872.

wave occasioned by the explosion swept over the ocean to the far-off coasts of Africa, Australia, and California; dust from the volcano was carried by high air currents entirely around the earth, and some of it continued to float for more than two years.

Mauna Loa, Mauna Kea, and Kilauea are widely known volcanoes in the Hawaiian Islands. Many of the loftiest peaks of South America, of Mexico, and of western North America, such as Mt. Shasta, Mt. Hood, and Mt. Rainier, are volcanic cones (Fig. 161). The towering cone of Mt. Fujiyama in Japan, which appears in many Japanese pictures, is almost a national idol.

Fissure Eruptions. — At different times in the past enormous quantities of lava have risen through fissures, or vents in the crust

FIG. 161. — The lofty volcanic cone of Mt. Shasta in northern California. (© *by Waters.*)

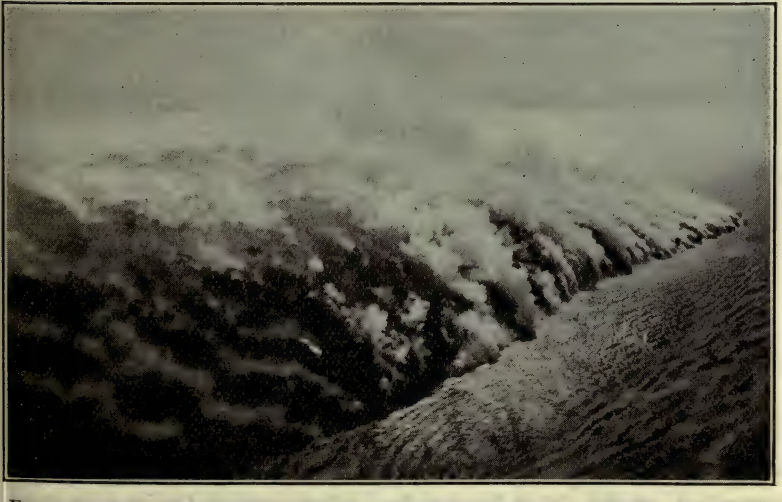


FIG. 162. — Lava from Volcano Sakurazima, Japan, flowing into the sea (1916).

of the earth, and have spread over the surrounding country in a lake of molten rock. In the basin of the Columbia and Snake

Fig. 163. — Cañon of the Snake River in Idaho where the river has cut a deep gorge in the lava plateau. The layers showing successive flow of lava, are plainly visible. (*U. S. Geol. Sur.*)

rivers in Washington, Idaho, Oregon, and northern California, outpourings of this kind have taken place repeatedly in past ages.

The different beds of lava formed by the successive outflows hardened into rock and now lie one upon the other, in some places attaining a total depth of 4000 feet (Fig. 163). Hills and mountains were buried in the lava and their tops now rise above it like islands.

This plateau of igneous rock extends over an area of more than 200,000 square miles (Fig. 164). Iceland, the peninsula of India,

Fig. 164. — The great lava plateau of the Columbia and Snake river basin. (*U. S. Geol. Sur. Bulletin 611.*)

the north of Ireland, and several other regions have had similar lava flows. The soil which is formed by the decay of this lava is often very productive.

Causes of Volcanoes. — These are not well understood, but the following points appear to be true: (1) that the interior of the earth is not liquid, but that (2) there are places where, for some

cause, reservoirs or huge pockets of molten rock exist; (3) that this molten rock is squeezed upward through vents by the great weight of solid rock above it, causing the quiet type of volcano and the great outflows of lava through fissures; (4) that the explosive volcanoes are due either to steam produced by water coming in con-

FIG. 165. — Distribution of volcanoes, shown by the shaded areas; dots indicate the locations of some of the active or recently extinct volcanoes.

tact with heated rocks below the surface, or, more likely, to steam and other vapors contained in the lava itself.

Distribution of Volcanoes. — The volcanic belts of the earth coincide closely with the earthquake belts (Fig. 165). Volcanoes, both active and extinct, are numerous in a zone around the Pacific Ocean. They also occur in the Mediterranean region, in the West Indies, in the East Indies, Iceland, East Africa, and on many scattered islands; in fact, about two-thirds of the active volcanoes are on islands. Many of these are regions of growing mountains. Volcanic cones frequently rise from the sea bottom, building up volcanic islands, such as the Hawaiian group and many others in the Pacific. Regions of old mountains and the interiors of conti-

nents are relatively free from active volcanoes. Only one volcano in the United States has been active since white men came to America, Lassen Peak in California, which erupted in 1915.

Summary

Volcanoes of the quiet type, such as those of the Hawaiian Islands, from time to time pour forth lava which spreads out and builds up broad, gently sloping cones. These and the great outflows from fissures seem to be due to the squeezing upward of lava, perhaps caused by the pressure of the overlying rocks. Volcanoes of the explosive type are alternately quiescent and active. These are treacherous and dangerous; they sometimes blot out entire cities by the showers of ashes and cinders and the clouds of suffocating gases which they emit. The cones built by such volcanoes are usually high and pointed and form some of the loftiest peaks in the world. In several parts of the earth lava has risen through fissures, has spread over thousands of square miles, and has built up lava plateaus such as the Columbia River Plateau and the "Deccan" of India. The cause of explosive volcanoes is not well understood but seems to be connected with steam and other vapors confined in the lava. A great volcanic belt nearly encircles the Pacific Ocean. There are volcanoes on the margins of other continents and on islands, but not many in the interiors of continents.

EXERCISE XVI

1. What is a "continental shelf"?
2. Explain why the continents are larger than they appear on an ordinary map.
3. To what are the ocean basins due?
4. Cite examples of rising and sinking coasts. Are such movements of the land common?
5. What are the evidences that the interior of the earth is hot? Is it thought to be in a molten condition?
6. Comment on the frequency and violence of earthquakes.
7. Give examples of severe earthquakes and of the extent of their destructiveness.
8. What is the probable cause of earthquakes?

9. Why do the movements that produce earthquakes occur only in the rocks near the surface of the earth?

10. Describe the movements of earthquake waves.

11. Where are the principal earthquake zones?

12. What are the two types of volcanoes and what are their chief differences?

13. Name and locate several volcanoes, (*a*) outside the United States, (*b*) in the United States.

14. What are fissure eruptions? Name regions in which extensive ones have occurred.

15. What are the suggested causes of volcanoes?

16. Where are the principal regions of volcanic activity?

17. On a wall map or other map point out the following places or geographical features mentioned in the chapter: Alaska, Naples, Peru, Sweden, Japan, San Francisco, Charleston, Lisbon, Messina, East Indies, West Indies, Caribbean Sea, Vesuvius, Island of Sicily, Mt. Etna, Hawaiian Islands, Mt. Shasta, Columbia River Plateau, Iceland, India.

CHAPTER XII

SURFACE FEATURES OF THE LAND; THEIR ORIGIN AND INFLUENCE

The major features of the land are

1. Mountains 2. Plateaus 3. Plains

Hills and Mountains. — In a comparatively level region the people sometimes call an elevation a few hundred feet high a

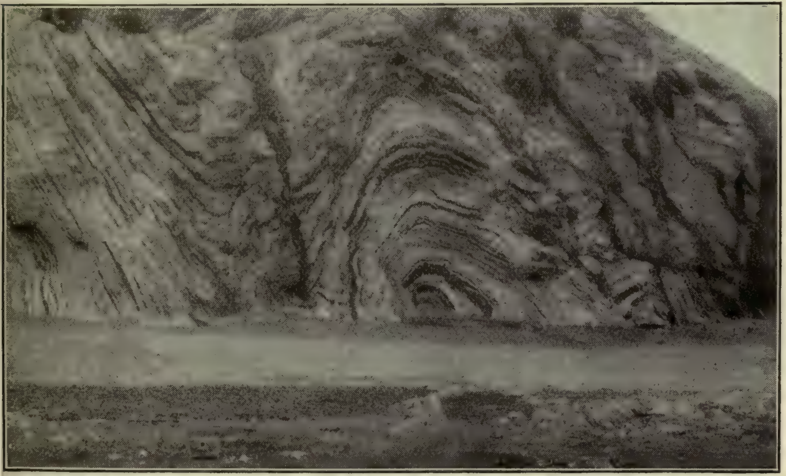


Fig. 166. — Intensely folded rocks in one of the mountains of Alaska. Such folding is frequent in mountain structures. (*U. S. Geol. Sur.*)

mountain, while in some other region a much higher elevation is called a hill. The so-called Berkshire Hills of Massachusetts attain a height of over 2000 feet, and the Black Hills in South Dakota and Wyoming rise to over 7000 feet. However, the word *hill* is usually applied to a low elevation, while the word *mountain* is applied to an

elevation measured in thousands of feet and having a small area at the top.

Origin of Mountain Ranges. — Mountain ranges may be thought of as wrinkles in the earth's crust due to the shrinking, or contracting, of the interior. The contracting has sometimes been attributed to cooling, but this is probably not the only cause, and possibly not the chief cause. At any rate our globe has undergone a slight shrinking and this has compelled the outer shell to wrinkle.

Volcanic Activity in Mountains. — Volcanoes are not confined to mountainous regions, for they are found also in the ocean; but

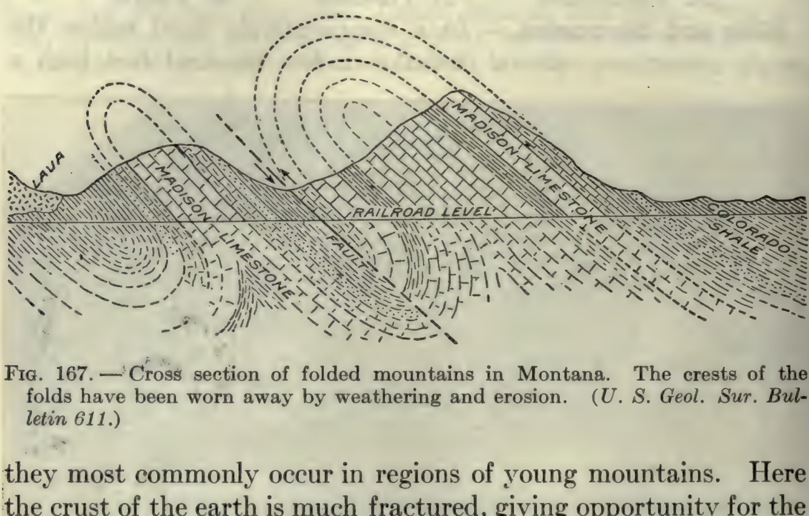


Fig. 167. — Cross section of folded mountains in Montana. The crests of the folds have been worn away by weathering and erosion. (*U. S. Geol. Sur. Bulletin 611.*)

they most commonly occur in regions of young mountains. Here the crust of the earth is much fractured, giving opportunity for the escape of lava. Here movements of the crust are taking place, tremendous pressure and great heat are developed, and other conditions favorable to volcanic activity exist. Many of the loftiest peaks in the younger mountain ranges are volcanic cones.

Mountains the Skeletons of the Continents. — The shape of a continent is much influenced by the direction and length of its mountain ranges, as may be seen in relief maps. The mountain skeleton of South America, for example, consists of one long, continuous system (the Andes) along the west coast, and a plateau with short ranges in eastern Brazil, and another in Venezuela at the

north. The broad areas between these mountains are plains made of the sediments carried down from the mountains. The shape of South America is very closely determined by its mountains. Europe has many ranges and spurs extending in various directions; one range forms the backbone of Scandinavia; another forms Italy; a mountainous plateau makes the Iberian peninsula; the Balkan peninsula is due to ranges and spurs extend-

FIG. 168. — Weathering of igneous rocks at high altitudes. Note the accumulation of weathered material on the slopes. (*U. S. Geol. Sur.*)

ing southward; and the British Isles were formerly a partially mountainous peninsula projecting from the continent. Most large peninsulas are due to mountain ranges or plateaus, but there are exceptions, such as Florida.

The Sculpturing of Mountains. — As soon as a part of the earth's crust rises above the surrounding level, it is attacked by the agents of weathering and erosion. The uplifting of the rocks fractures them, and the weathering agents and the mountain streams ply

FIG. 169. — Type of old, well-rounded mountains of the southern Appalachians in North Carolina. (*U. S. Geol. Sur.*)

their destructive work to better advantage. The loosened portions of rock creep or slide or are washed down the slopes, and the face of the rock is exposed anew to the weather (Fig. 168). Thus, mountains are denuded much more rapidly than plains because their steeper slopes are not able to retain a covering of soil and vegetation to protect them from further attacks of the weather.

Mountain Peaks and Passes. — Mountain peaks (which are not due to volcanoes) are resistant portions of the ranges. Wherever

FIG. 170. — Gracefully rounded mountains and rocky land characteristic of parts of New England. (*Courtesy of B. and M. R. R.*)

the mountain is much fractured, the air, water, frost, roots of trees, and other agents of waste work most effectively, and in such places notches and, possibly, passes are made, leaving the more solid and resistant rock standing up in the form of peaks (Fig. 167). In the notches, streams may head, and flow in opposite directions, and by their headwater erosion they may still further lower the notch, until it becomes a pass across the range. Such a pass may be used by a railroad in crossing the mountains. Most of the wild scenery of the mountains arises from this work of weather, ice, and water eat-

FIG. 171. — The broad plain in the foreground (Silverton, Colo.) is partly due to the deposition of sediments eroded from the mountains. The fan-like form of the deposits is evident. (*U. S. Geol. Sur.*)

ing away portions of the rocks and leaving other portions towering upward as peaks, domes, and spires (Figs. 168, 169).

Old and Young Mountains. — In their youth, mountains become sculptured, as described in the preceding paragraph. Sharp peaks, steep slopes, jagged cliffs, and narrow gorges characterize most young mountains; but with the passing of time the notches and valleys broaden, the slopes become less and less steep, and the peaks are rounded off (Fig. 170). If, during this process, the region is not uplifted, and the denudation continues for a great length of time, the highland will be worn down to a rolling plain. Such a surface is called a *peneplain*, meaning "almost a plain." The Blue Ridge and the mountains of New England, for example, are low, round-topped, and billowy (Fig. 169), because they are very old, while the Rockies and Sierra Nevadas, the Alps and Himalayas, with their sharp peaks, deep gorges, and precipitous cliffs are relatively young (Fig. 168).

THE INFLUENCE OF MOUNTAINS ON MAN AND HIS ACTIVITIES

Altitude and Temperature. — On an average, temperature diminishes one degree for each 330 feet of ascent; thus, an ascent of a mile in the torrid zone, for example, becomes equivalent to traveling poleward 800 to 1000 miles. At high altitudes the atmosphere is thin, and whatever heat the land receives from the sun is rapidly radiated back into the air and out into space, so that the highest peaks are cold and snow-capped the year round, even in the torrid zone. Because of their elevation, plateaus within the tropics are cool, and people find them agreeable places in which to live. In Mexico, Colombia, Venezuela, Ecuador, Peru, and Bolivia, the capital cities and most of the other cities are built at altitudes of from five to eight thousand feet above the sea. In India the English officials, merchants, and others who are able to do so, go to the mountains during the hot summer, and even the capital or seat of government is temporarily moved there. The same practice is followed by many Americans in the Philippines and by the Dutch in Java. In short, it is only by taking advantage of the

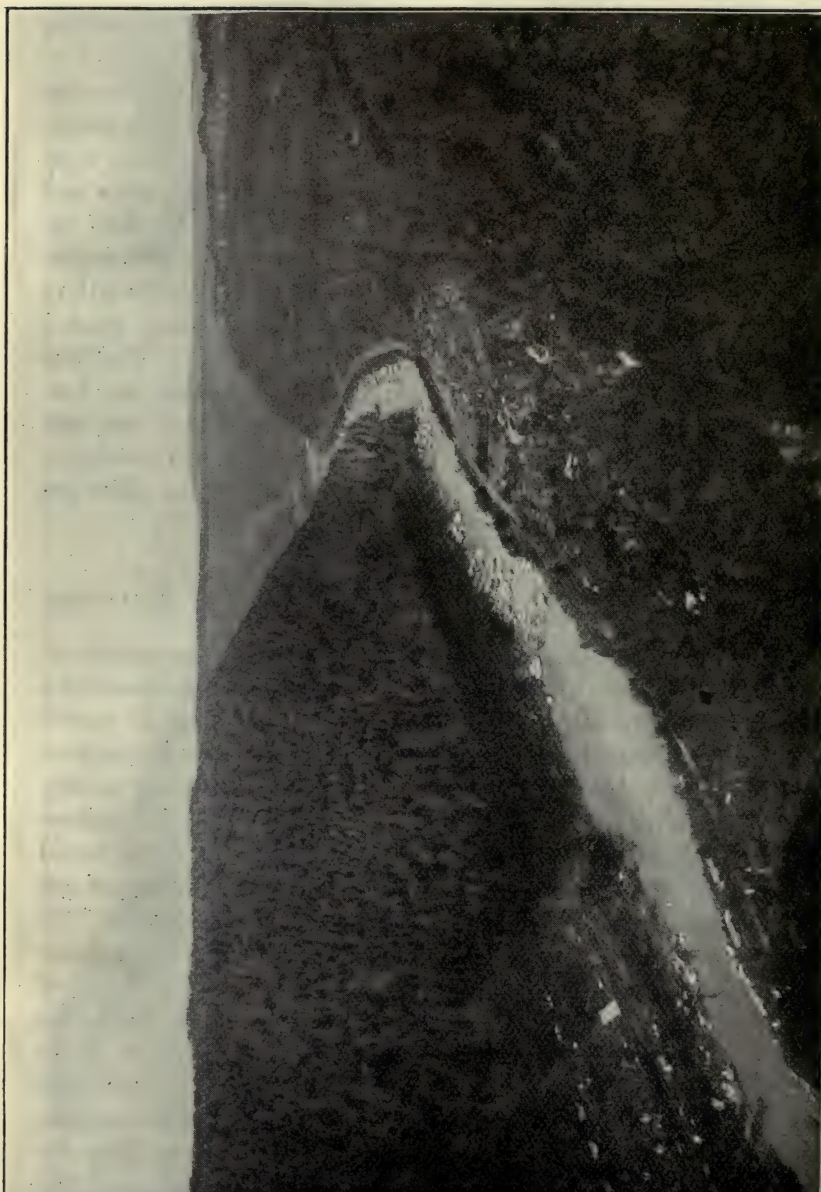


FIG. 172. — A young valley (New River, West Virginia), eroded in the Allegheny plateau. Note the V-shape of the valley and the even sky-line formed by the top of the plateau. (*U. S. Geol. Sur.*)

coolness of the mountains and plateaus that white people living in the tropics can retain health and vigor.

Rainfall and Agriculture. — Winds blowing over mountains are forced to rise; this air expands and becomes cooled, and consequently has to precipitate most of its moisture on the windward side (Fig. 206). For example, the rainfall on the west slope of the Cascade Mountains in Washington is several times as great as the average for the half of the state lying east of these mountains. By their direct and indirect effects the mountains of western United States render nearly 500,000,000 acres of our country unfit for agriculture; this region, four times the area of France, has a population of less than 5,000,000.

Erosion and Overloading of Streams. — As previously explained, weathering and stream erosion go on rapidly in mountains. The streams become heavily loaded with rock waste (Fig. 171), which they carry to the chief rivers, overburdening them, silting up their channels to the injury of navigation, and increasing the danger of floods. The Platte, Arkansas, and Missouri, heading in the Rocky Mountains, carry such enormous loads of silt that they are of scarcely any use for navigation. It is well to note in passing that most of the sediments and sedimentary rocks which form the great plains of the earth are made of materials eroded from the mountains, and that the rich alluvium which the Nile and other rivers spread over their flood plains is mostly brought from the same source.

Mountains as Forest Reserves. — When man takes possession of a new land, he clears the forests from the lowlands in order to use them for agriculture. But not so in the mountains; they, by their inaccessibility and unfitness for agriculture have little attraction for man, and therefore they become a natural timber preserve from which he may supply his needs when the more accessible timber is gone. Moreover, these mountain forests serve a highly important purpose in controlling the run-off and thus checking what might be disastrous floods. Our government is buying up large tracts of forest land in the Appalachian Mountains to be held for this very purpose.

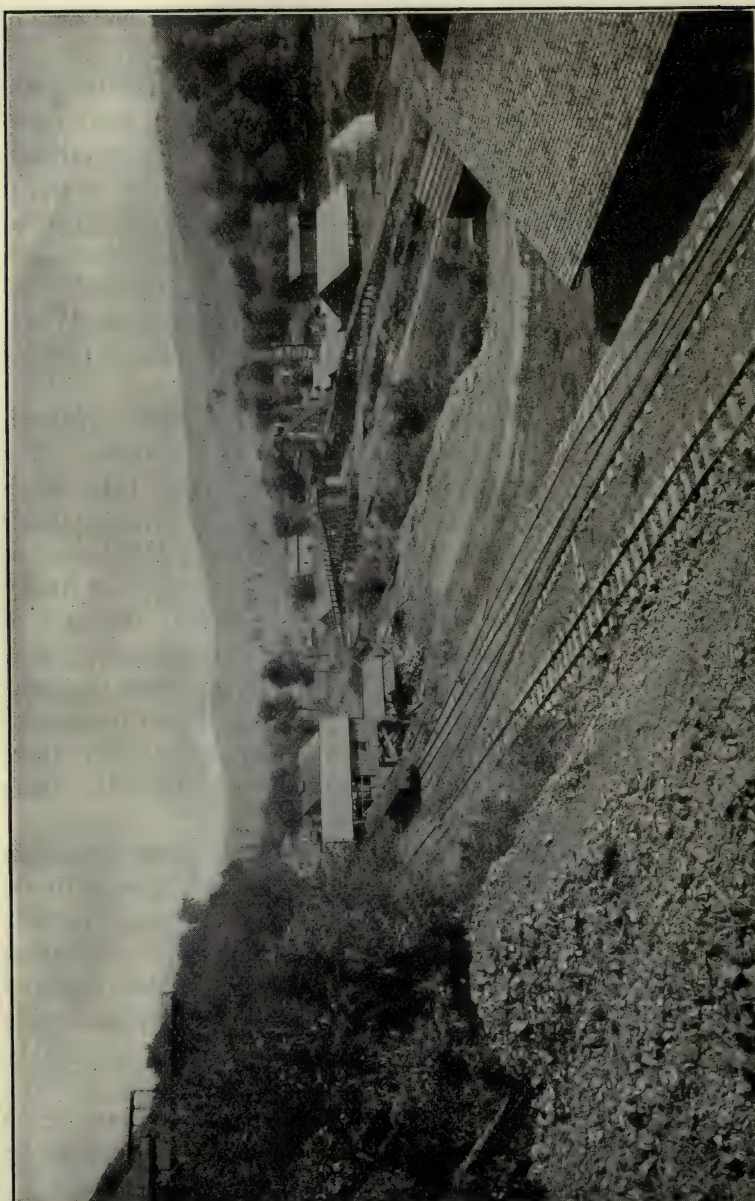


FIG. 173. — Iron-mining operations in a mountain valley in western North Carolina. (*U. S. Geol. Sur.*)

Mountains and Grazing. — Although mountains are unfavorable to agriculture, they usually contain tracts of land where cattle, sheep, and goats may graze. The rugged lands of Europe support many millions of such animals — cattle in Switzerland, sheep in Spain, and goats in Italy and the Balkan states. Our principal sheep-raising states, Montana and Wyoming, are both mountainous. Wherever the land is too rugged for cultivating crops,

FIG. 174. — Bitter Root Mountains in Idaho. Town of Wardner in the valley. (*U. S. Geol. Sur.*)

men turn to the grazing industries. This is also true in regions where rainfall is too light for growing crops, as in a great part of Australia.

Mountains and Mining. — In the mountain-building process the rocks are broken and cracks penetrate in all directions. In many instances mountain building is also attended by volcanic outbursts. The heat sets underground waters and vapors in motion, and these dissolve deep-seated minerals and carry them upward to the surface, where they are deposited in the cracks and fissures of the

rocks, forming mineral veins, as described in an earlier chapter (page 100). Later the vigorous weathering and erosion which take place in mountains bring these veins into view and prospectors discover them; thus the mountains are the chief sources of gold, silver, copper, and many other metals. There are exceptions to this general rule; the Alps, the Pyrenees, and our

Fig. 175. — A railroad (the Moffat Road) winding its way over the Rocky Mountains west of Denver.

own Appalachians are rather barren in metallic minerals, while mineral deposits are found in non-mountainous regions, as, for example, the lead and zinc deposits of Wisconsin and Missouri.

Mountains as Barriers. — High mountains are difficult to cross; animals, birds, and native plants may differ considerably on opposite sides of a high range. The building of roads and railroads across mountains is difficult and expensive (Fig. 175). As a result

only two good roads cross the Caucasus Mountains, and only a few cross the Pyrenees. Throughout its length of 5000 miles only one railroad completely crosses the Andes chain. One of the serious drawbacks to the development of the Andean countries of South America is the enormous difficulty of getting from the Pacific coast over the Andes into the interior of these countries. For example, a ton of coal which normally costs $10 or $12 at a port of Peru or northern Chile, costs from $50 to $80 a ton when it reaches interior

FIG. 176. — Among the peaks and passes of the Alps; a Swiss village high up in the mountains.

Bolivia. It is exceedingly difficult to lead armies with their cannon, supply wagons, camp equipment, etc., over mountains to invade the countries on the other side. So great are the advantages possessed by the defenders of mountain passes and roads that invaders frequently find it impossible to dislodge them. For these and other reasons, mountain ranges are good boundary lines between nations.

Mountains and Population. — The severe climate, scanty soil, difficulties of travel and transportation, and limited industries usually deter any very large number of people from settling in

mountains. In ten of our western states there are no more people than live in New York City alone. The more level parts of New York State have an average density of population more than 20 times as great as that of the mountainous parts. The plain of northern India has about 100 million people, while an equal area in the mountainous plateau of Tibet just north has not even

FIG. 177. — A mountaineer's cabin and family in the southern Appalachians. In many instances these families are so isolated that they have practically no contact with the outer world. (*Oeland.*)

one million. On the other hand, mountainous Switzerland is more densely peopled than lowland Denmark, and in the tropical part of South America the white population is usually more dense in the highlands than in the sultry lowlands.

Peculiarities of Mountain Peoples. — Some mountain regions are so isolated that the people who live in them seldom come in

contact with people from the outside. They retain quaint, old-fashioned ways, have odd customs, superstitions, and modes of speech, dress peculiarly, and preserve ideas and practices that may have disappeared elsewhere centuries before. Only a few of many illustrations can be given here. The mountain whites of the South are strikingly unlike the people outside the mountains (Fig. 177). Many of them have little education, rarely see newspapers or magazines, dress in homespun and home-made clothing, cling to old superstitions, are suspicious of strangers, and use many words and expressions that have passed out of use elsewhere. Some of these people never saw a trolley car or railway train, a mowing machine or a steamboat.

Fig. 178. — A mountaineer's wagon and team hauling freight back into the settlements of the southern Appalachians. (*Oeland.*)

In the mountains of Wales there are some 500,000 people who cannot speak or understand English, although Wales has been united with England for more than 500 years.

In the Pyrenees Mountains live a peculiar people numbering half a million, known as the Basques. They and their ancestors have been there so long that no reliable trace of their origin can be found. Their language shows no connection with any existing European language. France and Spain have been invaded and overrun by foreign foes time after time; wave after wave of invasion and conquest has rolled up to the base of the Pyrenees, but the Basques in their mountain retreat have remained for 2000 years or more almost untouched by any of these changes.

The Caucasus Mountains are a veritable museum of peoples and languages. Almost every important valley shelters a different tribe. It is said that Jewish families in the Caucasus still give their children names that were in use in Israel 2500 years ago and which have long since dropped from use elsewhere. The great difficulty of conquering mountain peoples is shown by the fact that Russia was able to subjugate 4,000,000 square miles in Siberia before the tribes of the Caucasus were brought under subjection. Such mountains are nature's fortresses into which remnants of defeated or oppressed peoples retreat and there live untouched by the influence of events outside.

Plateaus

Definition of Plateau. — Just as there is confusion between the terms *hill* and *mountain,* so there is indefiniteness in the terms *plain* and *plateau.* For instance, at the eastern base of the Appalachians an upland less than 2000 feet in elevation is called the Piedmont *Plateau,* while the region just east of the Rocky Mountains is known as the *Great Plains,* although the elevation reaches 5000 feet. The term *plateau* is applied to a land form of large area and considerable elevation (usually some thousands of feet) which rises rapidly above the adjacent land on one or more sides. The Great Plains east of the Rocky Mountains have no such rapid rise on any side and that may account for their classification as plains.

Types of Plateaus. — The Columbia River Plateau, built up of many layers of solidified lava, is described elsewhere. The Colorado Plateau, in which the Grand Cañon of Arizona has been eroded, is made of many beds of sedimentary rocks; these were uplifted, and, though a great thickness of rock has since been removed by erosion, the surface of the plateau still has an elevation of over 8000 feet. On the western side of the Appalachian highland is the Allegheny Plateau. Its steep eastern edge is often referred to as the Allegheny Mountains. A part of this plateau, lying in New

York just west of the Hudson River, has an elevation of over 4000 feet, and is there called the Catskill Mountains. Into the Allegheny Plateau rivers have eroded a maze of steep-sided valleys — some of them 2000 feet in depth. Between certain layers of rock are beds of coal; in fact, the Allegheny Plateau from Pennsylvania to Alabama is the greatest coal-mining region of the United States. In West Virginia, for example, the plateau is so cut into great hills and valleys that the region appears to be mountainous, and is usually so called (Fig. 172).

Arabia is a vast desert plateau, and Africa is a plateau continent. The loftiest plateau in the world is Tibet in southern Asia, rising to an elevation of 15,000 feet and having upon it mountain ranges that rise 14,000 feet higher; Mt. Everest, the highest of the Himalayas, reaches 29,002 feet. It becomes evident, then, that plateaus are not usually flat-topped table-lands, although some of them would be comparatively flat if streams had not cut valleys and cañons in them.

Life on High Plateaus. — In the temperate zone, high plateaus are cool in summer and bleak in winter. They are often windswept and nearly barren, as in Arabia and Mongolia. Some of the largest plateaus are arid or semiarid; the great desert belt, which includes central and southwestern Asia and the Sahara, is a belt of arid plateaus. In such an environment life is hard. Nomadic tribes, with flocks and herds, move from place to place in search of grass and water. Settled homes are the exception; law and government are weak, and robbery and raiding are common. (Read Huntington's account on pages 302, 303.)

It has been pointed out that in tropical lands like Mexico and western South America, the plateaus are the most agreeable and healthful places of residence and contain the major part of the population. The scarcity of rainfall, however, limits agriculture and prevents any very great advancement. Most plateaus have been uplifted as part of a mountain-building process and so are likely to have rich mineral veins. This is notably true in Mexico and South America, although it is not true of all plateaus; for example, the Piedmont Plateau of our southern states.

FIG. 179. — Mountains and plains of the eastern third of the United States. (*Model by Lorenz, Madison, Wis.*)

Plains

Character. — Some plains are very low and very level, while others have considerable elevation and are rolling or hilly. But low elevation and a generally even surface are implied in the word *plain.*

Coastal plains are stretches of low land, more or less sandy, on the coastal borders of continents. They are portions of the adjacent sea bottom which has been slightly uplifted and added to the land. Such a plain extends from New Jersey to Mexico along the Atlantic and Gulf coast of North America (Fig. 179).

Fig. 180. — A wheat field on the broad, level plain of the valley of the Red River of the North in Minnesota and North Dakota.

Interior plains. — The vast plains of Russia and Siberia and of central North America are examples of extensive regions which were once submerged beneath the sea. During their submergence, sand, clay, and other sediments were deposited in broad sheets. Later these were uplifted bodily and became parts of the continents. It has been pointed out (page 235) that mountains furnish most of the sediments of which such plains are made. Interior plains and coastal plains make up a large part of Europe and of the two Americas.

Alluvial plains, already discussed in connection with rivers, are made of the alluvium carried by streams, and deposited in deltas,

flood plains, alluvial fans, etc. Such plains are commonly found along the lower courses of great rivers, *e.g.*, the Mississippi, the Nile, the Ganges, and the Yangtze (Chapter IX).

Glacial plains are those made by the deposits of continental glaciers, as in the upper Mississippi Valley and northern Europe. They are sometimes called *till* plains.

Lake plains are due to silt deposited on the beds of lakes which no longer exist. Large plains of this kind are rare, but small ones

FIG. 181. — An irrigated valley among the mountains of Colorado. (*U. S. Bur. of Soils.*)

are common in regions where continental glaciers have been; one of the best examples is the rich plain of the Red River of the North, the bed of glacial Lake Agassiz (Fig. 180).

It is evident that alluvial, glacial, and lake plains may overlap or rest upon other kinds. For example, that of Lake Agassiz rests upon a glacial plain, which in turn is part of the great interior plain of North America.

Plains with Special Names. — The *prairies* are the grass-covered plains of our Middle West. They were treeless, or else had trees only along the streams. Sometimes patches of prairie

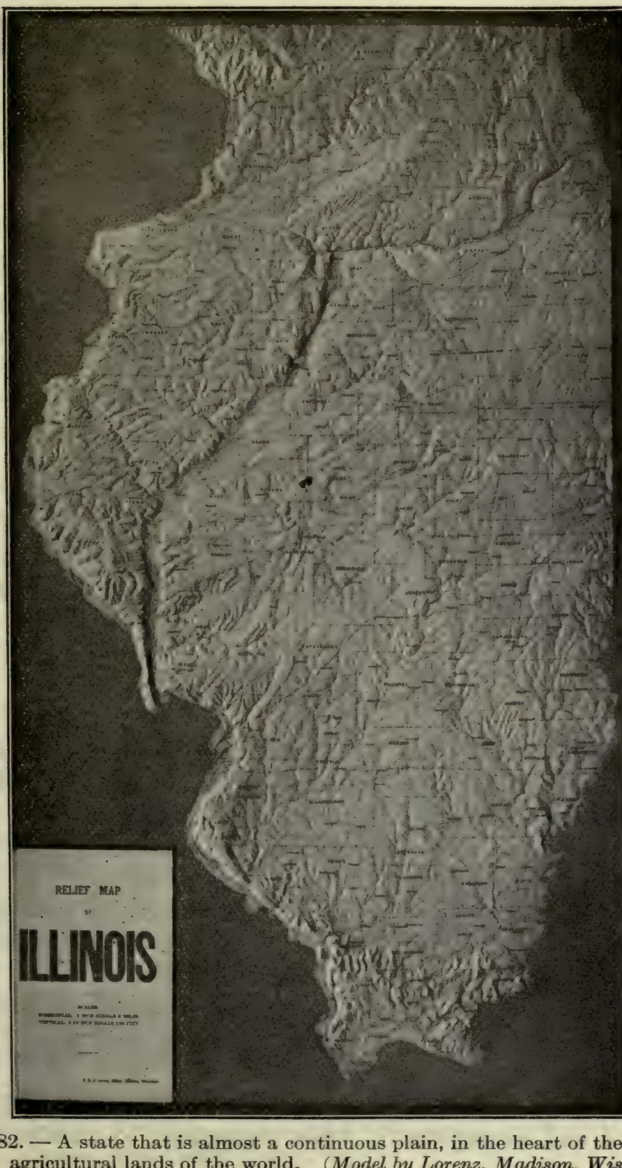


FIG. 182. — A state that is almost a continuous plain, in the heart of the foremost agricultural lands of the world. (*Model by Lorenz, Madison, Wis.*)

and of woodland were interspersed. There are similar grassy plains in various parts of the world called by special names, as, for example, *llanos* in Venezuela, and *pampas* in Argentina. The frozen, swampy plains of the Far North are called *tundras*, and dry plains such as those of southern Siberia and Russia are called *steppes;* not all steppes, however, are plains.

Plains in Different Climates. — The frozen plains of northern Siberia, Russia, and Canada are of small use to man. They yield him furs, but little else, and few people live there; these are the *cold plains.* In Australia, the Sahara, Patagonia, and Russian Turkestan there are *desert plains;* in Brazil the vast plain of the Amazon is a *tropical jungle,* so moist, hot, and unhealthful that white men cannot long remain there. But the well-watered plains of the temperate zone, with their deep soil, invigorating climate, and ease of travel, are regions of great productiveness. Here the chief food crops grow; here roads and railways may readily unite every part of the plain with every other, and facilitate the exchange of products. The ease of travel leads to the exchange of ideas and this promotes progress. Such plains are the ones referred to in the following contrasts.

Plains and Mankind

Mountains and Plains Contrasted. — (1) Mountains have a great variety of climate in relatively small areas, while plains are likely to have a uniformity of climate over a large area.

(2) Mountains tend to cause heavy rainfall upon small areas, while plains cause the rainfall to be distributed widely.

(3) Mountain streams are torrential and erode the land rapidly, while streams on the plains are sluggish and often deposit more than they erode.

(4) Mountains retard the movements of people and of armies, and hinder the building of railroads, roads, and canals, while plains encourage such undertakings.

(5) Mountains tend to isolate their inhabitants and keep them secluded and unprogressive, while plains lead to constant inter-

mingling of people and to that exchange of ideas which causes progress.

(6) Mountains are favorable to the *preservation* of forests, while plains favor their removal to make way for agriculture.

(7) Mountainous regions are likely to be cut up into small nations, as in western and southern Europe, while great plains are favorable to the growth of large nations, of which Russia is a notable example.

(8) Plains are suited to the growing of the great food crops, and can support a large population, while mountains raise little food and usually support a small population.

Summary

Plateaus are large areas of considerable elevation which rise steeply above the adjacent land on one or more sides. High plateaus are likely to be deeply cut by gorges, to be arid or semiarid, and hence lacking in population. The smaller and lower plateaus, of which the Allegheny Plateau is an example, may have abundant rainfall and be well forested. The great plateaus are nearly all surmounted by higher mountain ranges to which the aridity is in part due.

Plains are of various origins: they may be portions of the sea bottom, uplifted and added to the continent as coastal or interior plains; they may be due to deposits of rivers (alluvial plains), or of glaciers (glacial plains), or of lakes (lake plains).

Where the temperature and rainfall are favorable, plains are the ideal places for man's activities. Their level surface makes agriculture attractive, and makes the exchange of products and of ideas convenient; plains oppose clannishness and promote unity among the people; they are favorable to the growth of large nations and to the spread of civilization, but they are easy to invade and difficult to defend. They are the regions from which the world's supply of food must mainly be drawn — Russia, Argentina, central North America, and the smaller plains of Hungary, Germany, France, and India.

The earth's interior has undergone a contracting or shrinking process which has forced parts of the crust upward to form plateaus and mountains, and has caused other portions to sink and form ocean basins. These movements of the crust produce breaks or fractures which are favorable to general volcanic activity. The main mountain systems form the skeletons of the continents and largely determine their shape. By weathering and erosion, mountains are sculptured into ridges, peaks, domes, passes, gaps, etc. But as they grow old their tall peaks, precipitous cliffs, and sharp angles change to rounded summits, gentler slopes, and slowly decreasing altitude.

Condensed Summary of the Influence of Mountains

The influence which mountains exert upon man and his activities is one of the most positive and easily discernible of geographic influences.

Mountains whose general elevation is low or whose passes are low exert only a moderate influence.

In estimating the influence of mountains upon a country, consider what the conditions would be if the mountain area were a plain.

1. The climate of a mountain belt is made colder by its elevation. One mile upward equals 800 miles poleward. The tropical Andean countries can produce practically all crops.

2. High mountains force the passing winds to precipitate their moisture on the windward slope, producing arid or desert lands on the leeward side. Our western mountains render 500,000,000 acres unfit for agriculture.

3. The gradual melting of mountain glaciers equalizes the seasonal flow of rivers, thus reducing floods and aiding navigation and irrigation.

4. Excessive weathering and erosion in mountains often overloads a stream to the detriment of navigation, as in the Missouri, or to the benefit of alluvial plains, as in the Nile.

5. Mountains supply most of the sediments of which the plains are built up.

6. Fissures and fractures in the earth's crust and the circulation of mineral-carrying waters result from mountain building. Hence mountains are the natural home of metallic veins and of mining.

7. The relative inaccessibility of mountains tends toward the preservation of their forests, thus conserving the timber supply, and regulating the run-off.

8. Mountains discourage agriculture, but their lower slopes favor grazing, *e.g.*, in the Rockies, and the Alps.

9. The rigorous climate, scanty soil, difficulties of travel, and restricted industries of mountains attract but a scanty population. About the same number of people live in our ten mountain states of the West as live in New York City alone.

10. Mountains are often effective barriers to the intercourse of people, to the spread of population, to military campaigns, and to the building of roads and railways. They are nature's boundary lines for nations.

11. Mountains form a retreat for vanquished races; they isolate and preserve past languages, customs, laws, and ideas.

12. The isolation of mountain life accentuates non-social qualities, as seen in the clannishness of the Scotch mountaineer, the democracy of the Swiss, the insubordination of the Basques and the tribes of the Caucasus, the Tibetan's dislike of strangers, the lawlessness in the Balkans, and the suspiciousness and family feuds among our southern mountaineers.

EXERCISE XVII

1. Why are parts of the earth's crust wrinkled into mountains?
2. Why is there little soil on mountain slopes?
3. Why are high mountain tops cold?
4. Why does weathering proceed rapidly on mountains?
5. Why is stream erosion very active in mountains?
6. Why does a mountain range usually develop into a line of peaks?
7. Why are mineral veins likely to be found in mountains?
8. Why are mountains unfavorable to agriculture?

9. Why are forests likely to be found in mountains long after they have been cleared from the near-by plains?

10. Why are mountain tribes difficult to conquer?

11. Why do old languages and customs continue longer in mountains than on plains?

12. Why does a high mountain range make a good national boundary?

13. Why are volcanoes more common in mountainous regions than elsewhere?

14. Why are earthquakes frequent in young mountains?

15. Why are glaciers found in mountains when there are none on the plains near by?

16. Why is population sparse in mountainous regions?

17. Why are high plateaus usually arid?

18. Why are valleys and cañons deeper in plateaus than in plains?

19. Why are coastal plains usually sandy?

20. Why are alluvial plains usually fertile?

21. Why do glacial plains usually contain many lakes and swamps?

22. Why is rainfall more evenly distributed over plains than over mountainous regions?

23. Why are plains (generally) well suited to farming?

24. Why do large plains often lead to nations of large size?

25. Why are the people of the plains usually more unified than mountain people?

CHAPTER XIII

THE ATMOSPHERE

The atmosphere is part of the earth, not merely an envelope surrounding it. The atmosphere rotates with the rest of the earth and travels with it around the sun. Light as it is, the air has weight and is held by the attraction of gravity. Thirteen cubic feet of ordinary air weigh about a pound.

Composition. — Moist air rarely contains more than one or two per cent of water vapor. The following table shows the average composition of dry air:

	Per Cent of the Atmosphere
Nitrogen	78.00
Oxygen	21.00−
Argon	1.00−
Carbon dioxide	.03
Hydrogen[1]	.01

Function of the Different Parts. — *Oxygen* is the active gas of the air; life is impossible without it. So delicately are we adjusted to the proportion of oxygen in the air that a small reduction in the amount makes us drowsy and a large reduction may cause death. Review what is said of the atmosphere on pages 3–5.

Nitrogen is exceedingly inert or inactive. So far as animal life is concerned its chief function seems to be to *dilute the oxygen.* Plants require nitrogen, but they do not get it directly from the air. As explained on page 65, certain plants (particularly members of the clover family) are able to store it in usable form in nodules

[1] It is believed that the air at a great height (above 50 miles) is mainly composed of the very light gas, hydrogen, which can barely be detected in the lower air.

formed by soil bacteria on the roots. *Argon* is much like nitrogen, and is not known to serve any important purpose in the atmosphere.

Carbon dioxide (composed of carbon and oxygen) is exhaled in the breath of people and animals, and is one of the gases given off when things burn or decay. Every ton of coal that is burned pours into the air nearly three tons of carbon dioxide. Plants are able to take the carbon from the carbon dioxide of the air and to use it in building up their tissues, while the oxygen is (in the presence of sunlight) returned to the air.

Water vapor is of great importance, particularly because it supplies the rainfall, without which there could be no life on the land. It gives rise to clouds, dew, snow, fog, and hail; its presence makes the atmosphere a better blanket to protect us from the intense heat of the sun during the day and to prevent the rapid escape of heat from the earth at night.

Dust in the atmosphere varies greatly in amount at different times and in different places. Dust and bacteria are from 10 to 20 times as abundant in the air of cities as in that of the open country.

Depth of the Atmosphere. — There is no way of knowing how far the air extends upward beyond the lithosphere, but it is at least 300 miles, and probably more. However, at a height of 10 miles the air is too thin to support human life, and at 50 miles (where it is thought to be nearly all hydrogen), it must be extremely thin or rare. At its outer margin the atmosphere must blend so gradually with empty space that no boundary between them could possibly be fixed.

Pressure and Density. — Since the air has weight, it presses down upon the surface of the land and sea; this pressure is about 15 pounds upon each square inch, or about one ton on each square foot at sea level. Since the lower air supports the weight of all the air above it, this lower portion of the air is compressed. So great is this compression that the lower air, extending up to an elevation of 3.6 miles, contains one-half of the total atmosphere by weight. In other words, if we ascend a mountain 3.6 miles

above the sea, we shall have half of the atmosphere below and half above our level. So rare is the atmosphere on the highest mountain tops that men cannot keep alive there. Mt. Everest and others of the high peaks of the Himalayas have never been scaled.[1] Explorers cannot sleep at these high altitudes, and in this rare atmosphere they find the exertion of climbing so great that they can scarcely lift one foot above the other.

On a hot, sultry day when the air is full of moisture, we think the air is heavy, while on a clear, cool day it seems light; but just the opposite is true. Water vapor is lighter than air and when freely mixed with the atmosphere, makes the latter less heavy.

Fig. 183. — Illustrating the principle of the barometer.

The barometer is an instrument for measuring the pressure or weight of the atmosphere. The essential parts of a barometer are (1) a glass tube about 32 inches in length, closed at one end and open at the other, and (2) a cup of mercury. The glass tube is filled with mercury, and is then stood upright with the open end in the cup (Fig.183). The mercury in the tube will sink a little until it stands about 30 inches higher than the surface of the mercury in the cup, while the upper (closed) portion of the tube above the mercury will be entirely empty; that is, it will be a vacuum.

The ordinary barometer differs from this only in details (Fig. 184). It has a graduated scale along the tube, marked off in inches and fractions of an inch, so that an observer may tell at a glance "how high the barometer stands."[2]

The Principle of the Barometer. — Mercury is used in the barometer because it is the heaviest liquid, and does not freeze

[1] An expedition is attempting (1922) to reach the top of Mt. Everest.

[2] The *Aneroid Barometer* is an instrument which measures atmospheric pressure without the use of mercury or any other liquid; it is shaped like a very large watch and is more compact and convenient to carry than the mercurial barometer.

Fig. 184. — A barometer.

at ordinary winter temperatures. The principle of the barometer would be the same if any other liquid were used. Water might be employed (in warm weather), but in that case the glass tube must be about 34 feet long. Since the atmosphere exerts a pressure of about 15 pounds to the square inch, it is evident that the downward pressure upon the mercury in the cup is 15 pounds on each square inch, and this downward pressure of the air balances a column of mercury about 30 inches high (equal to a column of water about 34 feet high) in the tube of the barometer. If, for any reason, the pressure of the air upon the mercury in the cup changes, the mercury in the tube rises or sinks. If, for instance, the atmospheric pressure diminishes one-thirtieth, the mercury in the tube sinks one-thirtieth. Thus, by means of the barometer, we can measure changes in the pressure or weight of the atmosphere. The word *barometer* means *pressure measure*, just as thermometer means *heat measure*.

Uses of the Barometer. — If we ascend a mountain, carrying such a barometer with us, we shall find that the mercury in the glass tube gradually sinks as we go higher up the mountain. In this way the altitudes of places can be measured; for this purpose the aneroid barometer is convenient.

Important changes in the weather are preceded, accompanied, and followed by changes in atmospheric pressure. The laws governing these changes are so well understood that the weather can be partially foretold by the action of the barometer. All weather predictions sent out by the U. S. Weather Bureau stations are based upon observations of the barometer made at many stations and telegraphed daily to other stations.

Isobars are lines drawn on a map connecting places of equal atmospheric pressure (Fig. 196).

Heat in the Atmosphere

How the Atmosphere Is Warmed. — The sun is the source of practically all of our heat. It sends out or *radiates* waves of energy which travel outward from the sun in all directions through space, and a minute fraction (one two-billionth) is received by the earth. The waves of energy, usually called *rays*, pass through space and enter our atmosphere; some of their heat is absorbed directly by the air, but the larger part of it passes through the air and is absorbed by the land and water. During the night some of this heat is radiated back into the atmosphere and much of it escapes into outer space. Heat is also constantly radiated back into the air from the earth during the day. While the air absorbs some heat directly from the sun's rays, it is warmed still more by the waves which are radiated back from the earth.

The Air as a Blanket. — Clear air permits heat waves to pass through it readily, but clouds and even invisible moisture retard them. Thus, the atmosphere acts as a blanket which tempers the heat of the sun during the day and checks the rapid escape of heat from the earth at night. This benefits man in important ways. It is estimated that the temperature of the land would fall at night to 320° below zero F. if there were no atmosphere. It is believed that on the moon, where there is no atmosphere, the temperature rises far above the boiling point of water during the moon's day and falls more than a hundred degrees below zero during its night. The heat of day and the cold of night on the earth would be much more extreme if our atmosphere were thinner or contained less moisture and carbon dioxide.

Convection. — Warming the air causes it to expand and thus to become lighter, and being lighter, it tends to rise. This tendency of warm air to rise and cool air to sink causes a circulation called *convection*. A similar circulation is started when a dish of water or body of water is heated. Convection currents both in air

and in water are a highly important means of distributing heat. By means of these convection currents, including the winds, warm air and cool air are being continually mixed, usually to the comfort and benefit of man.

Day and Night Temperatures. — As a rule, the coldest part of the night is shortly before sunrise, for the dark part of the earth has received no heat since sunset and has been radiating heat all night. At sunrise this part of the earth begins to receive and absorb heat, and continues to absorb it during the forenoon and until about 2 P.M. in winter, and 4 P.M. in summer, when the warmest part of the day is reached. The earth is then radiating heat back into the air with the greatest intensity of the day; after that time (2 to 4 P.M.), the temperature grows cooler. Thus the hottest part of the day lags behind the noon hour; and for a similar reason the hottest part of summer lags behind the summer solstice (June 21).

Water in the Atmosphere

Vapor and Water. — The atmosphere is never absolutely dry, but the amount of water vapor which it contains varies from day to day and from place to place. Water *vapor* itself is invisible, but when it is cooled sufficiently the vapor condenses into droplets or drops of *water* and these are visible. *Condensation* is the change of invisible water vapor to visible water, due to cooling.

Evaporation. — At ordinary temperatures water is a liquid. When the temperature is raised to 212° F., water boils (at sea level) and passes into steam or vapor. It also passes *slowly* into vapor at temperatures much below 212° F. Everybody knows that clothes dry on the line, that mud "dries up," and that pools of water evaporate in the sun and wind. Evaporation is the process by which water becomes vapor and passes into the air.

Humidity. — On a sultry day in summer, the air is spoken of as being very *humid*, or moist. A cubic yard of air at 80° F. can hold a certain amount of water vapor; at 70°, it can hold less, and at 90° more. In an ordinary-sized schoolroom, say 20 feet square and

15 feet high, at 70° F. the air can hold about 6 pounds of water vapor. The actual amount of vapor which a certain body of air holds is called its *absolute humidity.* This is usually measured in grains per cubic foot; for example, 10 grains of water vapor per cubic foot of air.

Air which contains 75 per cent of the water vapor that *it is capable of holding at that temperature* is said to have a *relative humidity*

FIG. 185. — Cirrus clouds.

of 75 per cent. Relative humidity is, therefore, the percentage which the amount of water *actually* in the air forms of the amount which the air *could hold* at that temperature.

Saturation. — The warmer the air, the more moisture it can hold. When air contains all the moisture it can hold *at that temperature,* it is said to be *saturated.* So long as the air is not saturated, its moisture remains invisible, but when it passes the point of saturation, some of the water vapor condenses and becomes visible in the form of clouds, mist, fog, rain, snow, or dew.

The dew point is the temperature at which air becomes saturated, that is, reaches the point where it contains all the moisture that it can hold. If the air becomes any cooler, some of the water vapor in it will condense. If we breathe upon a cold pane of glass, for example, the breath is quickly cooled below the dew point, part of the moisture in the breath condenses and forms a film of water on the glass. If the glass were as warm as the breath, no such film would form. The ice pitcher or ice-water tank cools below the dew point the air that touches it, and the water vapor in the air is condensed on the outside of the pitcher or tank.

It will be seen that the dew point is not a fixed temperature, but is variable. If the air is hot and full of moisture, the dew point will be high, say at 80° or 85° F., but if the air is relatively dry it will need to be cooled many degrees before the point of saturation (dew point) is reached, perhaps to 35° or 40° F.

Clouds

Cause of Clouds. — The upper air is, as a rule, cooler than that near the earth. Upward-moving currents of air expand and are thereby cooled, and the moisture is condensed into tiny droplets which become visible, yet are light enough to float in the air. This visible water vapor, floating at high altitudes, forms *clouds*. They are easily blown before the wind, constantly changing their shape, and often dissolving under the warming influence of the sun or in warm air currents.

Kinds of Clouds. — Clouds are classified into four principal types: (1) Fleecy white clouds at very high altitudes are called *cirrus,* meaning hairlike; they are 8 or 10 miles high and consist of tiny crystals of frozen mist (Fig. 185). (2) *Stratus* clouds are those which lie in long, nearly horizontal bands or layers one above the other. They are seldom more than a mile or two above the earth and often cover a considerable part of the sky (Fig. 186). (3) *Cumulus* clouds are the great heaps of cloud which look much like piles of fluffy cotton or wool. They often form quickly on a summer's day, assuming picturesque shapes and taking on rich

colors at sunset (Fig. 187). (4) *Nimbus* clouds are the rain clouds. They are dense and dark and threatening. They are usually only a mile or two high and do not last long.

Colors of the Clouds. — Even the blackest clouds are bright and shining on the side toward the sun. "The darkest cloud has a silver lining." The dark clouds are black only because they are too dense for the sun to shine through. Other clouds are white because the sunlight passes through them, and the rays are

FIG. 186. — Stratus clouds.

scattered or diffused, as they are in passing through ground glass. The brilliant colors of the clouds at sunset are due to the action of the atmospheric vapor and dust upon the rays of the sun. Sunlight is made up of all the colors of the rainbow, and when beams of sunlight pass through the cloud particles at certain angles, the rays of light are separated into their various colors and give us the beautiful hues of the sunset.

Fog is really cloud stuff floating near the surface of the land or water. It is formed when moist air is cooled. Near Newfoundland the warm Gulf Stream and the cold Labrador current come close together; the warm air over the Gulf Stream is mixed with the cold air over the Labrador current and great banks of fog are produced. Dust particles and smoke particles form tiny centers

FIG. 187. — Cumulus clouds.

FIG. 188. — Clouds floating in valleys below the mountain tops, New England. (*Courtesy of B. and M. R. R.*)

upon which moisture condenses and produces fog. The London fogs are believed to be in part due to this cause.

Dew and Frost. — The dew does not "fall"; after sunset, in summer, the ground cools rapidly and soon the grass and shrubs are cool enough to condense the moisture in the air which touches them, and the moisture which they themselves exhale. The thin leaves of the grass and plants not only exhale moisture, but they also expose much surface to the air, and cool quickly, and so are the first objects to become wet with dew. Wood is a poor conductor of heat and therefore cools slowly. A board sidewalk may collect no dew when the grass on either side is dripping wet. Iron and other metals are good conductors of heat; they cool rapidly and often collect dew early in the evening.

FIG. 189. — Photographs of snowflakes. Note the characteristic hexagonal form. (*Photos by Bentley.*)

The moisture that collects on the outside of a glass of ice water is actual dew; so also is the moisture which collects on the window pane. The *white frost* that appears on objects on cool autumn mornings is frozen vapor which would have appeared as dew if the temperature had not been at 32° F. or lower.

Rain is due to the rapid condensation of water vapor in the upper air. We do not expect "rain from a cloudless sky," because the cloud is an intermediate step between vapor and rain. The warm

air of summer is able to hold a large amount of water vapor. When this warm, moist air rises and cools, clouds form, and if condensation proceeds far enough the tiny droplets unite, form into drops, and rain follows. Rainfall and snowfall are often referred to as *precipitation*.

Snow is not frozen rain; it is frozen vapor. Snowflakes form directly from water vapor without passing through the liquid state.

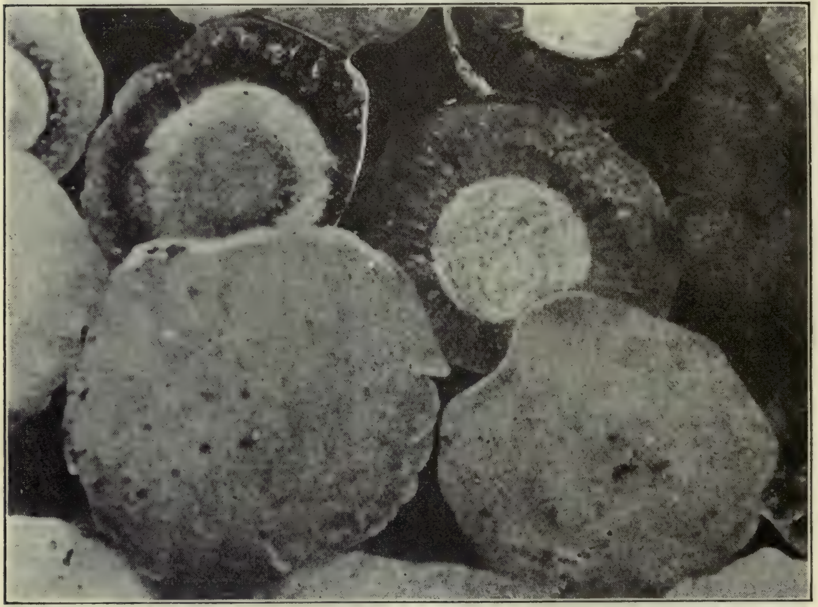


FIG. 190. — Hailstones, actual size. Note the interior structure.

Strangely enough, perfect snowflakes (which are ice crystals) always have six points or six angles. Many hundreds of snowflakes have been photographed, and they are always hexagonal (Fig. 189).

Hail is less common than rain because hail can form only under unusual conditions. If a large hailstone is cut in two, it is found to be made up of a snowy center inclosed by several shells of ice, like the formation of an onion (Fig. 190). Large hailstones form

only when the upper air is in violent commotion; a snowflake or frozen raindrop is caught in an upward-moving air current, carried up, then falls toward the earth, and is again caught in a rising current and carried upward, thus traversing alternately cool and warm layers of air and adding film after film of ice. In rare cases, hailstones as large as small eggs are formed. Hailstorms are often destructive to growing crops and farmers sometimes carry hail insurance.

The Main Facts about the Atmosphere Summarized

The atmosphere is as much a part of the earth as is the land or the water. It consists of a mixture of about 78 per cent nitrogen, 21 per cent oxygen, and small amounts of argon, carbon dioxide, water vapor, and dust. Oxygen is the active, life-giving element of the air; it is the cause of decay and combustion. Nitrogen dilutes the oxygen; it is required by plants, but they cannot take it directly out of the air; carbon dioxide is also essential to plants, and is taken directly from the air; water vapor supplies dew, snow, fog, clouds, and rain.

The atmosphere has weight, and the lower air is so compressed by the weight of the air above it, that one-half of all the air, by weight, forms a bottom "layer" only 3.6 miles deep. The high atmosphere is very thin or rare. At sea level the atmospheric pressure, due to the weight of the air, is about 15 pounds to the square inch or one ton to the square foot.

The barometer measures atmospheric pressure; it is used for measuring elevations and is also one of the principal instruments used by weather forecasters.

The air is warmed by the sun's rays as they pass through it, but it is warmed still more by the heat radiated back by the land and water. The atmosphere acts as a blanket inclosing the rest of the earth and protecting it from the intense rays of the sun by day, and checking the rapid loss of heat from the earth at night.

The warmer the air, the more water vapor it can contain. The air is said to be saturated when it contains all the water vapor it

can hold at that temperature. If air is cooled, its capacity for holding water is diminished, and when the point of saturation (the dew point) is reached, the invisible vapor condenses into fog, cloud, rain, dew, etc. Frost, snow, and hail are formed when the temperature is at or below the freezing point, 32° F.

Clouds are bodies of condensed vapor floating in the upper air. Their height varies all the way from less than one mile to 8 or 10 miles; the highest clouds are fluffy crystals or frozen mist. Fog is cloud stuff at a low elevation. Dew collects mainly on grass and other low vegetation, partly because they lose their heat quickly in the evening and partly because vegetation itself exhales moisture. The film of moisture which often collects on cold glass or metals is condensed from the air which comes in contact with these objects. Rain is due to the rapid cooling of ascending air and the resulting condensation of its vapor. If the temperature is at 32° F. or lower, the vapor turns directly to snow. Hail is frozen rain, formed under somewhat unusual conditions.

EXERCISE XVIII

I. Give the meaning of the following terms:

1. Barometer	6. Saturation
2. Evaporation	7. Convection
3. Condensation	8. Density
4. Radiation	9. Atmospheric pressure
5. Precipitation	10. Dew point

II. Give the principal cause or causes for each of the following:

1. Rising and falling of the barometer
2. The blackness of storm clouds
3. The sunset colors
4. The fogs near Newfoundland
5. The clouds around high mountain peaks
6. The dissolving or disappearance of clouds

III. Twenty-five "Whys":

1. Why is the atmosphere to be regarded as a part of the earth?
2. Why is the lower atmosphere more dense than the upper?
3. Why is the water vapor of the atmosphere of great importance to man?
4. Why is mercury instead of some other liquid used in the barometer?
5. Why may the barometer be employed in ascertaining the altitude of places?

6. Why does the dark side of the earth cool during the night?
7. Why does it cool more rapidly on a clear night?
8. Why does the atmosphere have the effect of a blanket around the rest of the earth?
9. Why does the surface of the moon undergo great extremes of temperature?
10. Why does air become lighter as it becomes warmer?
11. Why does our breath show on a cold winter's day?
12. Why do clouds form?
13. Why do clouds constantly change their shape?
14. Why does dew form?
15. Why does it form more quickly on grass than on the sidewalk?
16. Why does dew form more abundantly on a clear night than on a cloudy night?
17. Why does fog form?
18. Why is fog over the land more likely to appear in the evening or morning than in the daytime?
19. Why does a film of moisture form on the outside of a glass of ice water?
20. Why does "steam" sometimes collect on a person's eyeglasses when he enters a warm house in winter?
21. Why do we not expect rain from a clear sky?
22. Why does precipitation sometimes take the form of snow and sometimes of rain?
23. Why are hailstorms less frequent than rainstorms?
24. Why does not the cooling of the upper atmosphere always cause rain or snow?
25. Why is fog likely to occur in the vicinity of cities?

CHAPTER XIV

WINDS AND STORMS

How Differences of Temperature Cause the Movement of Air. — If an outside door of a house is opened on a cold day, there is an outflow of warm air at the top of the doorway and an inflow of

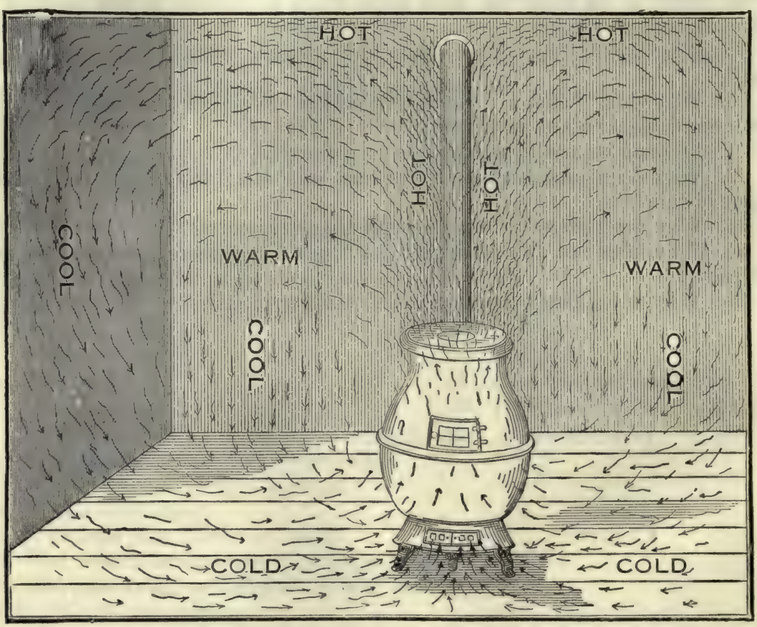


FIG. 191. — Showing the circulation of the air in a room containing a stove. (*After Tarr and McMurry.*)

cold air at the bottom. (Test this.) The inflowing cold air is heavier than the air of the room and pushes it up and out. A stove in a room warms the air near it, causing it to expand and so to

become lighter; the cooler air flows in toward the stove, becomes warmed, and in turn rises, thus setting up *convection currents,* and the circulation causes the entire room to become warm (Fig. 191).

Relation of Temperature and Pressure to Wind. — Since cold air is heavier than warm, a region of cool or cold air is one of greater air pressure, and a region of warm air is one of less air pressure, or *low pressure.* Toward such a region the heavier air on any side flows, causing winds. It is a basic principle that *air moves toward regions of low pressure and away from regions of high pressure.*

How Winds Are Named. — A north wind is one that blows *from* the north; a southeast wind is one that blows *from* the southeast, etc. Winds are named according to the direction they blow *from.*

The Cause of Wind Temperatures. — The air over a warm body of water or land absorbs heat from it and becomes warmer. Air over a cold body of water or land imparts heat to it, and itself becomes cooler. Thus, in either case, the air tends to take on a temperature similar to that of the land or water upon which it rests. Air is capable of holding and carrying a large amount of heat; it parts with this heat gradually as it blows over a cool region, or absorbs heat gradually as it blows over a warm region. Thus, winds from the south bring heat which they previously absorbed; and winds from the north take up heat as they pass, making the region cooler.

Air Drainage. — On summer nights, the cool air of the hills flows down the hillsides into the valleys, and forces the warm air in the valleys to rise. Thus the low ground gets the cool air and may have frost, while the higher ground gets the lighter warm air and may escape frost. This principle of *air drainage* is important to fruit growers. Orchards and vineyards are usually safer on the slopes of hills or even on the summits, if not too high, than in the valley bottoms.

Land and Sea Breezes. — Land warms and cools more rapidly than water. During a summer day the land along the coast becomes warmer than the adjacent ocean, and the cooler air from the sea flows in, giving a cool, refreshing *sea breeze.* At night the land cools more rapidly than the sea, and soon after sunset the air over

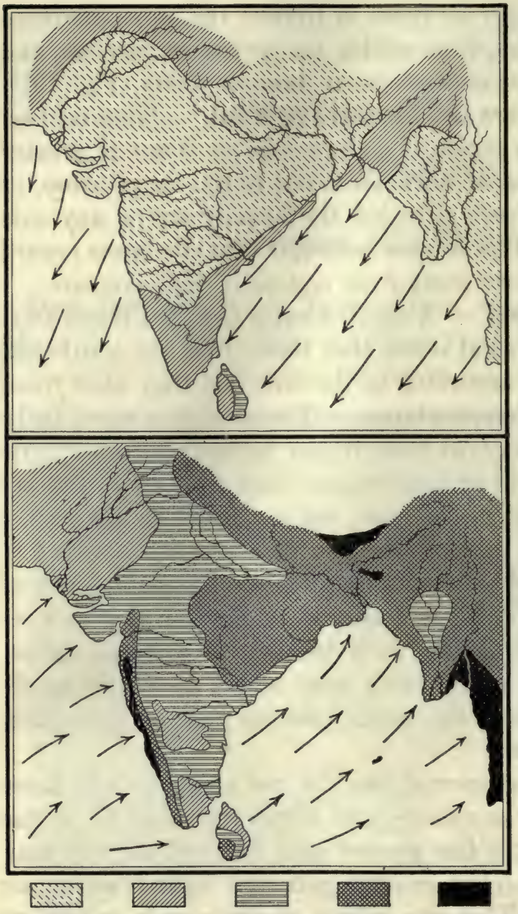


FIG. 192. — *Upper figure,* — direction of Monsoon winds and distribution of rainfall in India during the winter; *lower figure,* — the same during the summer.

the sea is warmer than that over the land and a breeze flows out to sea, giving a *land breeze.* The land breeze continues until after sunrise, when a reversal gradually takes place. Such breezes affect the land only a short distance (seldom more than 10 or 15 miles) back from the shore. Similar breezes, though not so well developed, occur near lakes. These cooling breezes are one of the attractions which draw people to the seashore and to lake shores in summer.

The Monsoons. — These are land and sea breezes on a large scale; they shift with the change of the seasons instead of with the change of night and day. Monsoons exist in many parts of the world but they are most perfectly developed in southern and southeastern Asia, including India, part of China and Japan, and the adjacent ocean (Fig. 192). In our summer when the sun is north of the equator, the land of Asia becomes warmer than the sea, and an

FIG. 193. — Prevailing winds of the earth. (*After Tarr and McMurry.*)

ocean wind sets in from a general southerly direction, carrying much moisture with it. The monsoon winds are of utmost importance in India, where the summer or wet monsoon begins in June and continues until September. In our winter when the sun moves south of the equator, central Asia becomes colder than the Indian Ocean and for about three or four months the monsoon blows from the land to the sea. Between the summer and winter monsoons are periods when the winds are shifty and uncertain.

Importance to India. — So important to India is the rainfall of the summer monsoon that its failure brings almost complete ruin to crops, and at various times millions of the people of the afflicted regions have starved to death. Sometimes the famines are so widespread and severe that famine relief has to be given to millions of the population for periods varying from one to four years. For example, the famine of 1896–97 in India affected an area of about 225,000 square miles, with a population of 62,000,000 people, and the government had to expend millions of dollars in the direct relief of distress. An idea of the frequency of these famines may be formed from the fact that during the last three decades of the nineteenth century, no less than four severe famines devastated the country.

The Wind Belts of the Earth [1]

The Heat Equator and Its Seasonal Movement. — Some part of the torrid zone is always receiving the sun's vertical rays. Owing to the inclination of the earth's axis and to the annual revolution of the earth, the sun's apparent path seems to shift its position gradually from north of the equator to south of it and back again. In our summer the sun's vertical rays fall upon the northern half of

[1] If the surface of the earth were perfectly smooth, and were either all land or all ocean, the wind system of the earth would be relatively simple. But it is not smooth and furthermore it is part land and part water. Since the land heats and cools much more readily than the sea, and since the continents are of various shapes with mountain ranges extending in many directions, it follows that the *actual* wind system is not simple. It is convenient to speak of "wind belts," but it is not to be understood that these extend continuously around the earth like zones. Most of the "belts" are fairly definite over the ocean, but quite indefinite and sometimes non-existent over the land. The account of the wind system as here given is to be thought of as a generalized explanation, true in theory, but in reality much modified by the distribution of the land masses and the oceans.

the torrid zone, and in our winter they fall upon the southern half. The *heat equator*, or line of greatest heat, is therefore nearly always entirely within the torrid zone.

Since the great land masses (continents) are mainly in the northern hemisphere, this hemisphere becomes somewhat hotter in the northern summer than does the southern hemisphere during its summer. This causes the heat equator, which shifts north and south with the sun, to be more largely in the northern hemisphere than in the southern (Figs. 194 and 195). In summer the land becomes hotter than the ocean and the heat equator bends farther

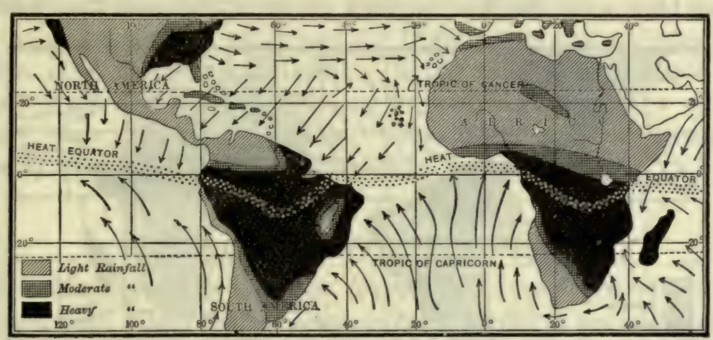


Fig. 194. — Map showing the position of the heat equator, direction of the winds, and the rainfall of part of the earth in our winter — December to February. Compare with Fig. 195. (*After Tarr and McMurry.*)

north over the continents than over the oceans in the northern hemisphere, and farther south in the southern hemisphere.

The Doldrums or Region of Equatorial Calms. — Since the heat equator is in the middle of a belt of high temperature and low pressure, the air is constantly rising. This belt of rising air, known as the *doldrums* or *equatorial calms*, is a few degrees in width and is practically always north of the equator; it is well defined only over the sea. In it sailing ships have sometimes been becalmed for days or even weeks. The constantly rising and cooling air gives a heavy rainfall, and a sultry, unhealthy climate.

The Trade Winds. — These are winds which, on the sea, blow rather steadily toward the heat equator from both sides, supplying

the air that is constantly rising in the doldrums. If the earth did not rotate on its axis, these winds would blow from the north and south, but the rotation causes the trade winds to blow from the northeast and the southeast, hence they are called the *northeast trades* and the *southeast trades*. Their steadiness led sailing vessels to make use of them, and this may have given rise to their name. The trade winds, of course, migrate alternately north and south with the change of seasons. They bring rainfall when they blow from sea to highlands, as they do in northern South America and Central America; they are drying winds causing deserts when they blow over the land as they do in Arabia and the Sahara.

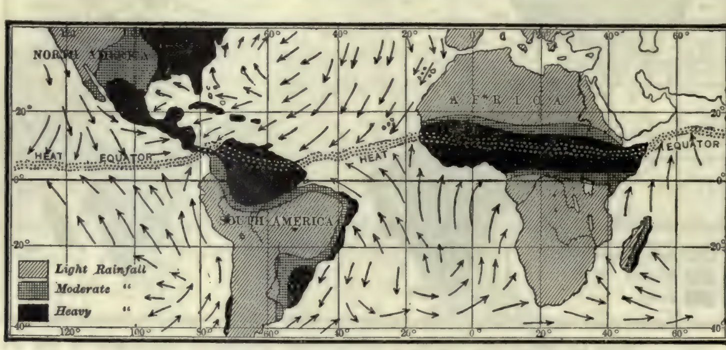


FIG. 195. — Map showing the position of the heat equator, the direction of the winds, and the rainfall of a part of the earth in our summer — June to August. Compare with Fig. 194. (*After Tarr and McMurry.*)

The Horse Latitudes. — The air which rises in the doldrums precipitates most of its moisture in rising; at a considerable height the air spreads out and flows both northward and southward as upper currents, called the *anti-trade winds,* because they blow in a direction *opposite* to the trades. This air which has become cooled and hence heavier, begins to sink toward the earth when it reaches latitudes of 30° to 35° each side of the equator. Since it is sinking and hence coming under greater pressure, it becomes warmer, and having previously lost most of its moisture, the air is in condition to absorb moisture, not to precipitate it. These regions of settling air near the tropics of Cancer and Capricorn are

called the *horse latitudes*. They migrate north and south with the seasons, as do the trades and doldrums, and are always dry or nearly so. They therefore bring the "dry season" to lands which they visit in their seasonal movements northward and southward.

The Prevailing Westerlies. — Not all of the air of the anti-trades settles to the earth in the horse latitude belt; much continues to move farther toward the poles, settling as it progresses. The earth's rotation causes this air to swerve toward the right in the northern hemisphere and toward the left in the southern, giving rise to the wide belt of east-moving wind known in both hemispheres as the *belt of prevailing westerlies*. This belt covers most of the two temperate zones and the frigid zones, and includes all of the great nations of the earth. While the *prevailing* winds of this belt are from the westerly quarter, yet, as we know by experience, they are very changeable. The cause of this changeableness is discussed later (pages 276–280).

The Wind Belts Summarized

The *heat equator* is a line or narrow belt connecting places of highest heat. The *doldrums* are a region of calms and high temperature covering an irregular area a few degrees on each side of the heat equator where the air rises and precipitates its moisture in heavy rains. The air which constantly flows in from the northeast and the southeast to displace the lighter air of the doldrums forms the *trade winds*. These may bring rainfall when they blow from the ocean to the land, but otherwise they are drying winds and are an important cause of the great deserts, as the Sahara, for example. Their steadiness on the sea favored sailing vessels and possibly led to the name, *trade* winds. The doldrums and the trades prevail in the torrid zone. The *anti-trades* are the upper return currents of air flowing poleward from the doldrums and, in part, settling near the tropics of Cancer and Capricorn. These belts of sinking air are regions of relative calm and dryness and are known as the *horse latitudes*. The heat equator, the doldrums and trades, and the horse latitudes all migrate a little northward

in our summer and southward in our winter, due to the same causes that produce the change of seasons, namely, the revolution of the earth around the sun and the fixed inclination of its axis. The winds of the temperate and frigid zones form two great circumpolar whirls, moving in an easterly direction in both the northern and the southern hemispheres. The *prevailing westerlies* give the kind of climate which is most favorable to mental and bodily vigor; therefore, regions with this climate have the highest civilization.

Storms and Weather Changes

Frequent Changes of Weather. — Most of the people living in the United States are accustomed to frequent changes of weather.

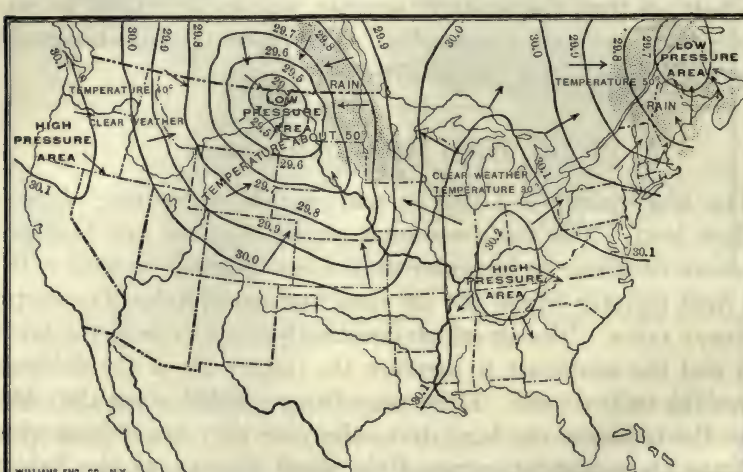


Fig. 196. — Weather map showing the isobars around two areas of low pressure, and a less important area of high pressure. Note that the arrows indicate winds blowing toward the "low" and away from the "high."

The wind sometimes changes its direction several times during a day, and the thermometer rises or falls many degrees during the same period. A day may begin with clear skies and bright sunshine, and in the course of a few hours clouds may gather, rain pour down in torrents, and the sky again be clear before evening. The

causes of these changes will be discussed in the following paragraphs.

Regions of High and Low Pressure. — People sometimes say "as fickle as the weather," implying that the weather changes its mood rapidly and with little cause. Of course every such change has a cause. Practically all these rapid changes are connected with changes of atmospheric pressure. If at this moment you were to receive telegraphic messages from places widely scattered over the United States, and these messages told the height of the mercury in the barometer, you would find that the atmospheric pressure differs at different places quite irrespective of altitude. In regions of low pressure the air is rising, and in regions of high pressure it is sinking. Wherever the air is warmer and lighter

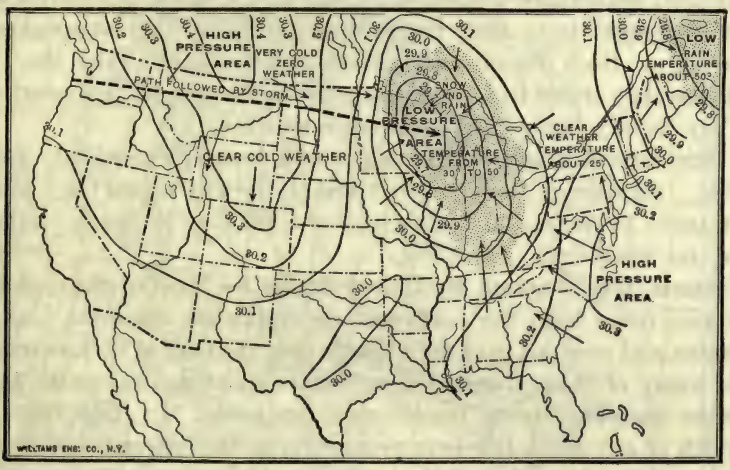


FIG. 197. — Weather map for the day following that shown in Fig. 196. The "low" has moved eastward several hundred miles.

than that around it, it rises or is forced upward by the inflow of heavier air.

The ascending air expands and cools and may give rain or snow. Descending air is likely to be cool and relatively dry. A large region of ascending air (low pressure) is called a *low,* and a

large region of descending air (high pressure) is a *high*. Such regions of high or low pressure are of very large extent, covering thousands of square miles.

Movements of the Air in a Cyclone. — A low is spoken of as a *storm*. The air which flows toward such a center does not move straight in, but, like other winds in the northern hemisphere, it is deflected toward the right by the earth's rotation. This causes the inflowing and ascending air to have a circular or spiral movement, as shown in Figs. 196 and 197. Such areas of inflowing and rising air are called *cyclones* or *cyclonic storms*. They occur in the belt of prevailing westerly winds and so are carried along with the prevailing wind toward the east or northeast.

Anti-Cyclones or Highs. — If air rises in certain regions, other air must somewhere descend to replace it. Areas of descending air are indicated by a high barometer, signifying high atmospheric pressure. Such regions are called *anti-cyclones*. Like the cyclones, they travel from west to east with the prevailing westerlies. They usually bring clear and cooler weather.

The rate of movement of highs and lows is exceedingly variable. Sometimes they move a third of the way across the United States in 24 hours, and again a high or a low may be nearly stationary for some time (Fig. 198).

Storm Tracks across the United States. — Most of the cyclonic storms come from the northwest or southwest, cross the United States, and pass out over the Atlantic near the Gulf of St. Lawrence. So many of these storms follow certain quite definite paths that maps showing storm tracks may be made. In Fig. 199 the width of any black line is in proportion to the frequency of storm movements along that path.

Influence of the Passing of Highs and Lows upon the Weather. — Most of the rapid changes of weather are caused by the passing of highs and lows. Since the wind blows in toward low-pressure centers, and out from high-pressure centers, and since both of these are carried across the country in the westerlies, it is clear that much changing of wind direction must be caused. If a low is passing north of a place, say Chicago, the wind in the region of

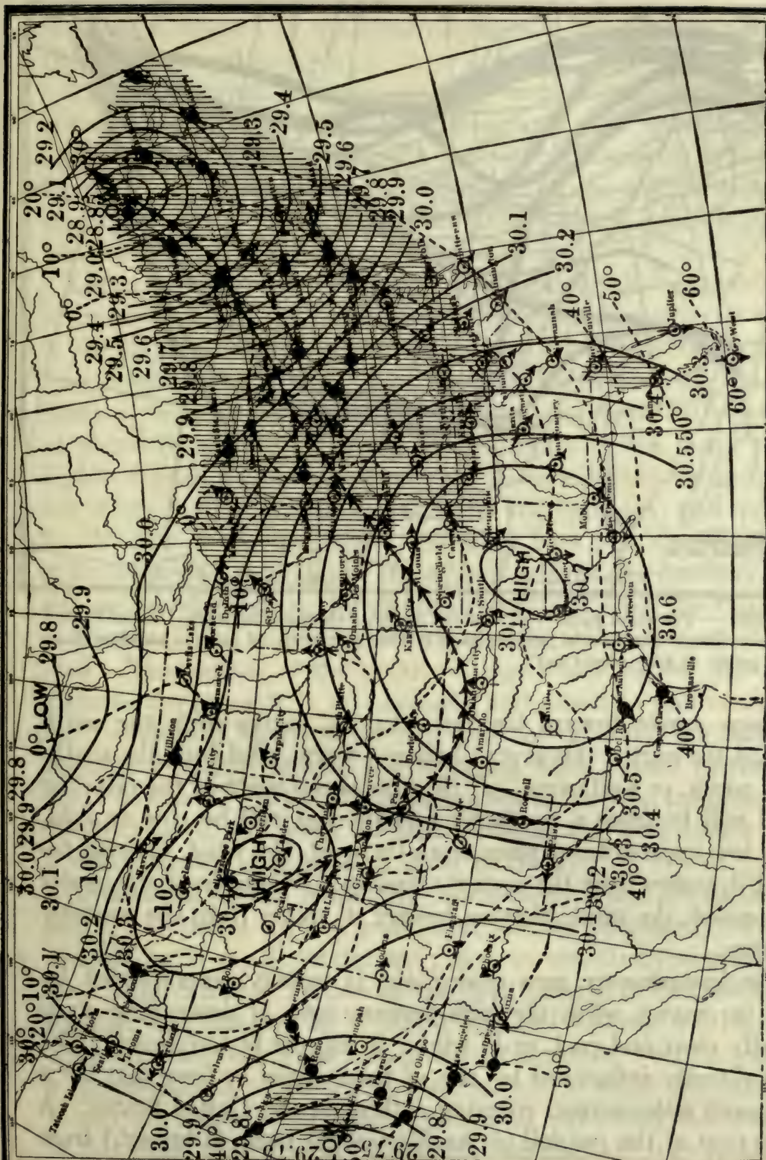


FIG. 198. — Weather map. The shaded area received rainfall on this day. Arrows indicate the direction of the winds. The continuous line of arrows indicates the path followed by the "low" across the United States. The solid lines are isobars and the numerals with them indicate the height of the barometer in inches. The dash lines and their numerals represent temperatures. (*From Milham.*)

FIG. 199. — Principal paths followed by cyclonic storms across the United States. The width of the line is proportional to the frequency of storms moving along the path. (*After Van Cleef.*)

Chicago moves toward the low, that is, moves from the south toward the north; this gives Chicago a warm wind from the southeast, south, or southwest. If the low passes south of the city, the wind will be from a northerly quarter and will be cool or cold. As a low approaches a place from the west, the wind, blowing toward it, comes from the easterly quarter. When the storm center has passed, the wind, blowing toward it, comes from the westerly quarter.

The low-pressure area (rising air) is usually accompanied by rain (or snow), while the high-pressure area of descending air is usually clear and cool, or in winter it may be bitterly cold. The area directly influenced by one of these highs or lows may be a thousand miles across, covering a third of the United States. A large part of the rainfall of the Mississippi basin is brought from

the Gulf of Mexico by winds moving toward low-pressure areas in the northern states.

Thunder Storms. — These are most common when the weather is hot. In our latitude they occur most frequently on hot summer afternoons. During the day the ground and air above it become very warm; the air rises rapidly, expands, cools, and its moisture condenses; great heaps of cumulo-nimbus clouds quickly gather and rain falls, usually in a vigorous shower.

Lightning is an electric charge leaping from one cloud to another or from a cloud to the earth (Fig. 201). Each tiny drop of water in the air carries a little charge of electricity. When clouds gather very rapidly, as they do before the breaking of a thunder storm, many of these tiny drops unite into larger ones; their little charges of electricity combine, causing every droplet in the cloud to be highly charged; hence the cloud itself becomes highly charged with electricity. It discharges violently by the lightning, and quietly by the fall of the raindrops. So-called heat lightning does not differ from other lightning. It simply is occurring so far away that we see its reflection in the clouds, but do not hear the thunder.

Thunder is due to intense vibrations in the air set up by the lightning. The passing of the electric charge which we call lightning disturbs the air, sets it in vibration, and sound is produced. If the discharge of electricity is very near the observer, the crash of thunder instantly follows the lightning flash. Such discharges are to be feared. If the discharge is a few miles from the observer, the thunder is not heard for some seconds and then comes with a rolling sound, echoing from cloud to cloud.

Tornadoes, though frequently miscalled cyclones, are quite different. Cyclones cover a great area, are not necessarily violent, and seldom do any direct damage; they are constantly passing over the United States. Tornadoes are small areas of *exceptionally* low pressure accompanied by *rapidly* rising and *violently* whirling air. They are often only a few rods broad; at the center there is usually a funnel-shaped, whirling, black cloud, within which the pressure is very low indeed. So violent is the wind and so low the pressure in this cloud that trees are uprooted, buildings are torn to pieces,

FIG. 200. — Prevailing direction of the surface winds in July. Note that in the eastern half of the United States the winds are mainly from the south and southwest, bringing moisture from the Gulf of Mexico. (*After Day.*)

FIG. 201. — Remarkable electric display at Spokane, Wash., about 2:30 A.M., July 13, 1914. (© *C. R. Lewis.*)

and people killed. Usually tornadoes are attended by lightning, by a most violent downpour of rain, and often by hail.

SUMMARY OF STORMS AND WEATHER

The rapid and frequent changes of weather in most parts of the United States are mainly due to the passing of low-pressure areas, called *cyclones*. These lows are near the center of slowly rising and rotating bodies of air of wide extent; they move in a general west-to-east direction, like great eddies in the prevailing westerly winds. Most of them enter North America from the Pacific and the larger number of them follow tracks which pass near the Great Lakes and out through the St. Lawrence Valley. The same storms, or similar ones, traverse the Atlantic and move on across Europe.

Areas of high pressure, or highs, usually follow the lows, each, as a rule, moving across the United States in three or four days. The cyclones, or lows, being areas of rising and cooling air, usually bring rain or snow. The anti-cyclones, or highs, being areas of descending air, are usually dry and cool in summer and cold in winter. The frequent passing of cyclonic storms across the United States causes in-drafts of moist air from the Gulf of Mexico and these furnish most of the rainfall for the Mississippi Valley. Our Atlantic coast region receives rain from the Atlantic in a similar manner.

The passing of successive highs and lows causes rapid changes of the wind, cold and warm waves, wet and dry spells, and a general uncertainty of weather. Tornadoes are much smaller than cyclones, much less frequent and, unlike cyclones, are usually violent and destructive.

EXERCISE XIX

Test Questions on Winds and Storms

1. How can it be proved that air has weight?
2. What is meant by pressure of the air?
3. Why is the pressure of the atmosphere greater at sea level than on a mountain top?
4. What instrument is used for measuring the pressure of the atmosphere?
5. How does heating the atmosphere affect its weight or pressure?
6. When an outside door is opened in cold weather, why does air flow out at the top and in at the bottom?
7. Why does cool air, on a summer evening, flow down the hill slopes into the valleys?
8. What becomes of the warm air thus displaced from the valley bottoms?
9. Why, in winter, is a current of cool air often found flowing down the stairways of our houses?
10. Why is the air near the ceiling of a room warmer than that near the floor?
11. Why do hot air and smoke rise in chimneys?
12. Why does water flow down a slope? Why does air flow from a place of higher to one of lower pressure?
13. Why do land and sea breezes alternate on coasts?
14. Explain the cause and importance of the monsoons.
15. What is meant by a *north* wind, or a *south* wind? What rule is followed in naming the winds?

16. What is the heat equator? Why is it not parallel to the earth's equator?

17. Where do the sun's rays fall vertically about March 21? September 21? June 21? December 21? Why this change?

18. Why does the heat equator change its position from month to month?

19. What and where are the doldrums?

20. Why are the doldrums called a "belt of calms"? In what direction is the air moving in this belt? Why?

21. Why is the belt of calms rainy? What continents are crossed by it?

22. What are the trade winds? Why so called?

23. What are the anti-trades? Why so called?

24. From what directions do they blow? Why?

25. Under what conditions do they bring rain?

26. What are the horse latitudes? In about what latitude are they found?

27. What is the direction of air movement in the horse latitudes? Why are they dry?

28. Why do all of these belts move alternately north and south?

29. What and where are the prevailing westerlies? Why so called?

30. Why is this belt in the northern hemisphere of more than ordinary importance? Why less important in the southern hemisphere?

31. What is a low-pressure area, or a low?

32. Describe the movements of the air at and near a low.

33. What is a cyclone? Why does the air of a cyclone have a spiral motion?

34. What causes air currents to be deflected toward the right in the northern hemisphere and toward the left in the southern?

35. What are anti-cyclones, or highs?

36. Why do cyclones usually bring rain and anti-cyclones clear weather?

37. From what directions do the cyclones of the United States most commonly move? Do they usually originate in the United States? What path do they commonly follow in leaving North America?

38. How does the frequent passing of highs and lows across the United States affect our weather? Why?

39. Why are the cyclonic storms of especial importance to the Mississippi basin?

40. Explain the cause of thunder and of lightning. What is "heat lightning"?

41. What is a tornado? How does it differ from a cyclone?

CHAPTER XV

CLIMATE AND ITS INFLUENCE

Climate and Weather. — The *weather* of a place may change several times in a day; the *climate*, however, is the average of weather conditions over a long period. A dry climate need not be free from times of wet weather, and a climate classed as cool may have periods of very hot weather. *Climate is the average of weather.* Within the tropics only are weather and climate the same, or nearly the same.

Changes of climate take place, but such changes are too gradual to be detected except over very long periods. For example, the climate of North America was colder in the Ice Age than it is now, and it was warmer in the coal-forming periods; fossils of tropical palms are found in icy Greenland, and glacial deposits in tropical Africa. An essential quality of climate, however, is its permanence or unchangeableness through long periods of time.

Elements Which Make Up the Climate of a Place. — The most important of these are (*a*) temperature, (*b*) moisture, and (*c*) winds. The average temperature of a place depends mainly upon (1) its latitude, (2) its altitude, (3) its nearness to the sea, and (4) the direction of the prevailing winds. The moisture of the air supplies rainfall, a fundamental requirement for all life. The winds are the great carriers of heat and moisture and so they directly affect the temperature and rainfall.

How the Earth Is Warmed. — Practically all of the heat which warms the earth comes from the sun. The waves of energy sent out by the sun traverse space without either warming or lighting it. Though the space between the earth and sun is always filled with waves which carry both heat and light, yet this space is as dark as night and intensely cold. When, however, any of these

waves that are radiated from the sun *strike an object,* say the earth or even grains of dust or droplets of water in the air, these *objects* are warmed and illumined.

Go out on a clear night before the moon has risen, and look out into space; it is all dark excepting where the stars appear as points of light. It is hard to believe that this dark space is completely filled with waves from the sun, capable of producing light, yet such is the case. Later, the moon rises into the space which seemed so dark, and behold the face of the moon shines brilliantly. But what causes it to shine? It shines by reflecting light received from the sun. If there were hundreds of moons scattered through this dark sky, they would all be shining by reflecting the sun's light. Clearly, then, this space which appears dark to us is filled with waves that produce light. Although the moon changes in position every hour of the night and every night of the year, it never (except when the earth comes between it and the sun causing an eclipse of the moon) gets out of reach of the sun's rays, simply because all space surrounding the sun is filled with the waves or rays radiated from it. When these waves are traveling through space they manifest neither heat nor light; but the instant they strike any object, the object is illumined and itself sends out waves of actual light by reflection. If light enters a darkened room through a small hole or crack, the dust particles in the air show exactly the path of the rays of light. If there were no dust in the room, the pencil of light would not be noted.

Effect of Oblique and of Vertical Rays. Latitude and Temperature. — The reason that the poles are colder than the equatorial regions is not that they are farther from the sun, for this small difference in distance is of little account. The temperatures in the polar regions are lower because of the earth's spherical shape. So far away is the sun that those of its rays which strike the earth act substantially as they would if they were moving in parallel lines. If other conditions are the same, the amount of heat received by a square mile of the earth's surface depends upon the number of sun's rays (or waves) which strike it. If one square mile receives the sun's rays perpendicularly, and another square mile receives them obliquely, the former receives more rays than the latter. A point on the equator receives on an average during a year nearly three times as much heat as the pole receives.

In Fig. 202, the lines *AB*, *AC*, and *BC* are all of equal length; *BC*, upon which the rays fall at right angles, receives the heat of 12 rays; but *AB*, of the same length as *BC*, but on which the

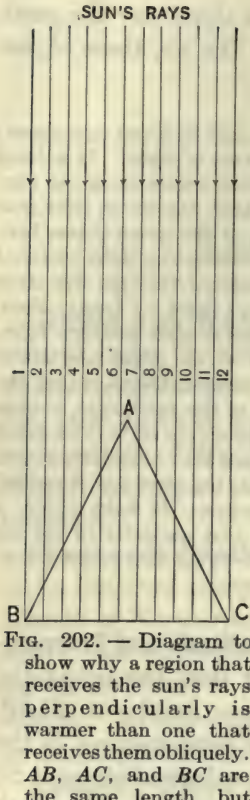


FIG. 202. — Diagram to show why a region that receives the sun's rays perpendicularly is warmer than one that receives them obliquely. *AB*, *AC*, and *BC* are the same length, but *BC* receives the heat of twice as many rays as *AB* or *AC*.

rays fall obliquely, receives only 6 rays, and hence only half as much heat. This explains one reason why the frigid zones are cold.

The second reason arises from the fact that rays which fall upon the equatorial region pass through less atmosphere (*DK* in Fig. 203) than do the rays that fall upon the polar regions (*AM* in Fig. 203). The more atmosphere the sun's rays pass through, the more heat is absorbed from them before reaching the surface of the land or sea. These two causes make the frigid zones cold, and a great amount of snow and ice has accumulated there. When the sun does shine upon the frigid zones, its heat is used up merely in melting some of the snow and ice. The torrid zone is warmest because there the sun's rays pass through the atmosphere by the shortest path, and because more rays strike each square mile of surface than in any other zone.

Why We Have Winter When the Earth Is Nearest the Sun. — It will be recalled that the earth's orbit is a slightly flattened circle, or an ellipse, and that the sun is not at the center but at one of the foci (*F* and *F′* in Fig. 204), a little on one side of the center. Recall that, as the earth journeys around the sun, its axis constantly remains tilted at the same angle ($23\frac{1}{2}°$), and in the same direction (toward the pole star).

As shown in Fig. 6, page 12, the northern hemisphere is tipped toward the sun in our summer, but away from the sun in our winter, causing this hemisphere to receive much more heat in summer than in winter even though the earth is actually $2\frac{1}{2}$ million miles nearer the sun in winter. The people of the southern hemisphere have

their summer when the earth is nearest the sun, and therefore would be expected to have warmer summers than we have. However, the great amount of ocean in the southern hemisphere so tempers the summer climate there that it is no warmer than ours.

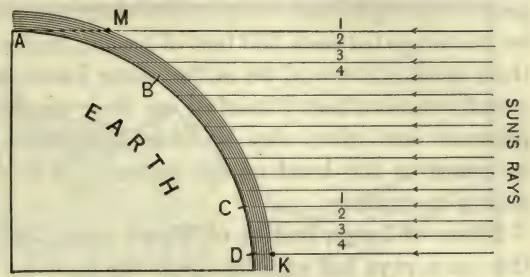


FIG. 203. — Diagram to illustrate why the sun's heat is more effective in the torrid zone than in the temperate or frigid zones. Note (1) that the same number of rays fall upon the small area *CD* as upon the large area *AB;* and (2) that a polar ray passes through the atmosphere by the long path *MA*, while a tropical ray passes through the atmosphere by the shorter path *DK*. Both of these conditions contribute to the higher average temperature of the tropics.

Effect of Altitude upon Climate. — As

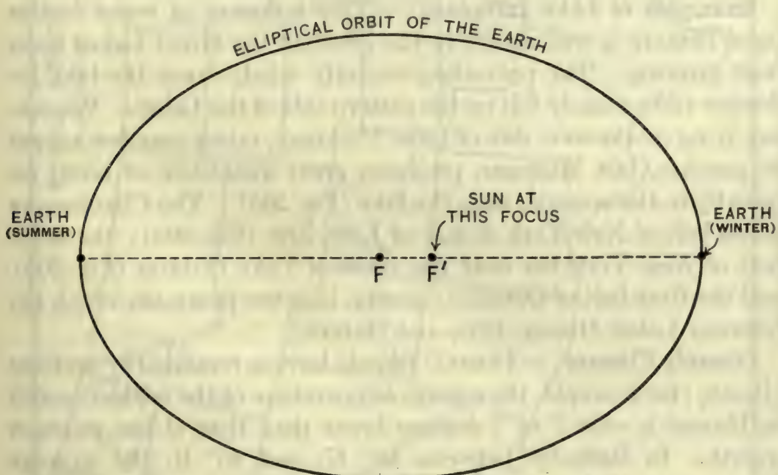


FIG. 204. — A much-flattened ellipse, with its two foci, *F* and *F'*. Although the earth is nearer the sun in our winter than in our summer, the northern hemisphere is tipped away from the sun, and this gives us our cold season. The above ellipse is flattened very much more than is the elliptical orbit followed by the earth in its yearly revolution around the sun.

previously explained, temperature decreases one degree Fahrenheit *on an average* for each 330 feet of ascent, hence highlands are cooler than lowlands would be in the same location. Mountain ranges usually receive heavy rainfall on their windward slopes, but large plateaus are often dry because the winds lose their moisture in rising to the level of the plateau, or in passing over the bordering mountains.

Effect of Large Bodies of Water upon Climate. — Even though the sun's rays fall equally upon the land and water, the land becomes much warmer, for it requires about four times as much heat to raise the temperature of water one degree as it does to raise the temperature of the same amount of land one degree. Thus, the continents and the air above them become much warmer in summer than do the oceans and the air over them. Water also gives up its heat more slowly than land. Therefore, the effect of large bodies of water is to produce a steadiness or equability of temperature between day and night and between summer and winter.

Examples of Lake Influence. — This influence of water bodies upon climate is well shown in the effect of the Great Lakes upon fruit growing. The prevailing westerly winds cause the lake influence to be mainly felt on the eastern side of the Lakes. Wisconsin, lying on the west side of Lake Michigan, raises very few grapes or peaches, but Michigan produces great quantities of both, especially in the counties near the lake (Fig. 205). The Chautauqua grape belt of New York is east of Lake Erie (Fig. 205); the apple belt of New York lies near the shore of Lake Ontario (Fig. 205), and the fruit belt of Ontario, Canada, is in the peninsula which lies between Lakes Huron, Erie, and Ontario.

Oceanic Climate. — Oceanic islands have a remarkably uniform climate; for example, the *average* temperature of the coldest month in Hawaii is only 2 or 3 degrees lower than that of the warmest month. In latitudes between 40° N. and 40° S. the average temperature of the air over the sea differs only 2 or 3 degrees between day and night. Coast lands are more uniform in temperature than interiors of continents. This is especially true of coasts which receive their prevailing winds from the sea, as is

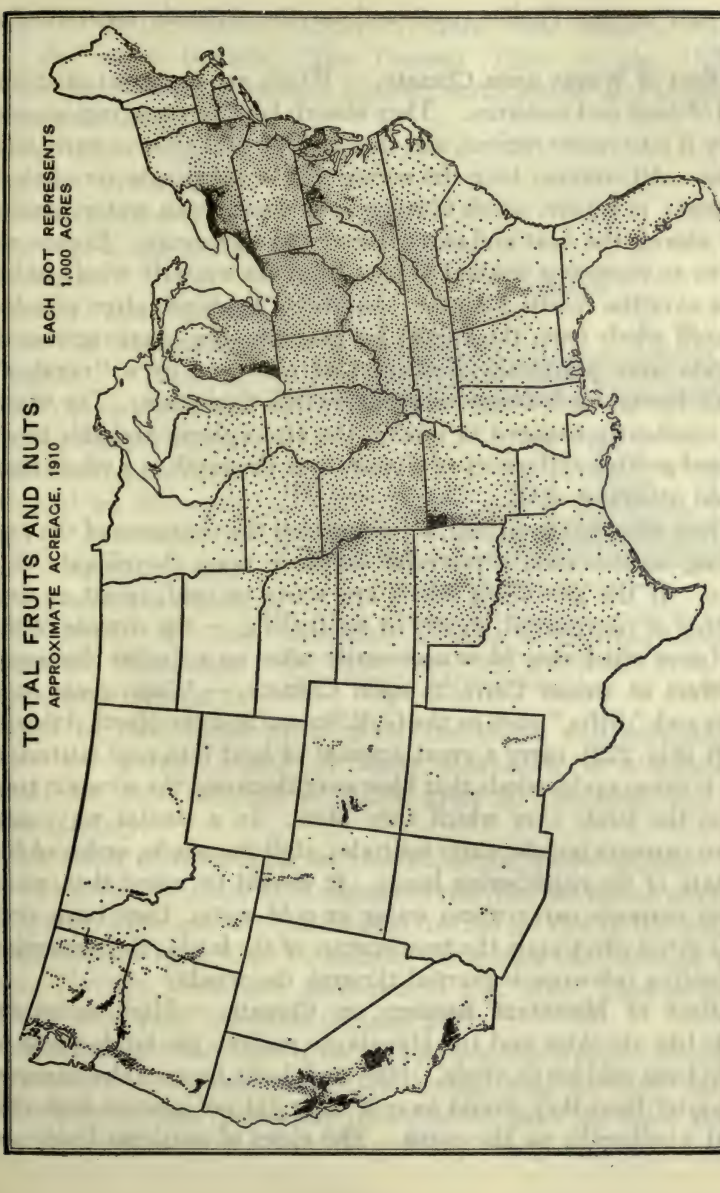


Fig. 205. — The black areas are regions of intensive production of fruits. (*U. S. Dept. of Agr.*)

the case on our Pacific coast and on the Atlantic coast of Europe.

Effect of Winds upon Climate. — Winds are the great distributers of heat and moisture. They absorb heat in warm regions and carry it into cooler regions, and they convey cold air into warm latitudes. All summer long the oceans of the temperate zones store up heat; in winter, winds blowing over these ocean waters gradually absorb the heat and carry it over the continents. Europe receives an enormous amount of heat from the westerly winds which blow over the North Atlantic. Southerly lands are often invaded by cold winds from the north; for example, the orange groves of Florida were practically destroyed at one time by a "norther" which brought a freezing temperature into that state. The winds are constantly engaged in mixing the atmosphere, and this tends toward greater uniformity of climate over the earth as a whole than would otherwise exist.

From what has been said, it follows that the character of the prevailing winds exerts a powerful influence upon the climate of a place. If the prevailing winds are warm or cold, moist or dry, oceanic or continental, steady or fluctuating, — the climate of the land over which they blow necessarily takes on a similar character.

Effect of Ocean Currents upon Climate. — Warm ocean currents and "drifts," such as the Gulf Stream and the North Atlantic Drift (Fig. 222), carry a great amount of heat into cool latitudes; this is taken up by winds that blow over them and the winds in turn warm the lands over which they blow. In a similar way, cold ocean currents invade warm latitudes, chill the winds, and cool the climate of the neighboring lands. It should be noted that, while ocean currents carry warm water or cold water, they have very little *direct* effect upon the temperature of the lands; their warming or cooling influence is exerted through the winds.

Effect of Mountain Barriers on Climate. — High mountain walls like the Alps and the Himalayas protect the lands south of them from cold north winds. Italy and India have milder climates in winter than they would have if they did not possess such efficient windbreaks on the north. The cities of northern India are

from 10 to 15 degrees warmer in winter than those of China in the same latitude. The Central Plain of the United States has no such protection against north winds, and in spring these sometimes sweep down from Canada and do serious damage to fruit and sensitive crops in our southern states.

North and South Sides of Mountain Ranges. — There is usually a marked difference between climatic conditions on the north side and on the south side of mountains in the temperate zone; for example, the region lying north of the Caucasus Mountains in southern Russia is subject to cold, bleak winds from the north, and only hardy crops are grown. South of these mountains is a different world, for here subtropical fruits grow in profusion and in perfect safety.

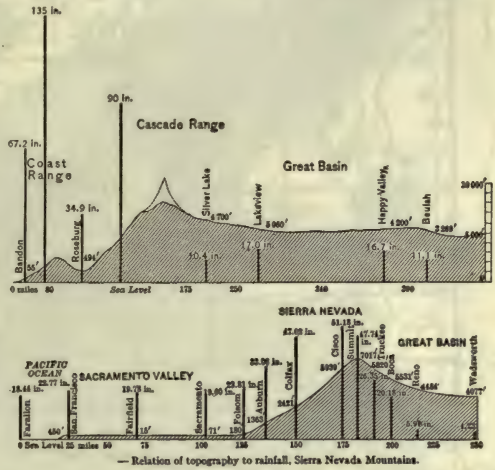


FIG. 206. — Diagram showing the extent to which precipitation is caused by mountains. Note in the upper diagram the great effect of the low Coast Range. (*After Bowman.*)

The effect of mountains on rainfall is still more marked; for example, the west coast of Washington receives 140 inches of rainfall a year, while eastern Washington, on the lee side of the mountains, receives from 7 to 15 inches. Note also the effect of the Sierra Nevada Mountains as shown in Fig. 206. This general topic is more fully discussed on page 235.

Isotherms are lines drawn on a map to connect places of equal temperature. For example, an isothermal map for July has a series of lines, each connecting places which have the same average temperature during July (Fig. 208); a map showing annual

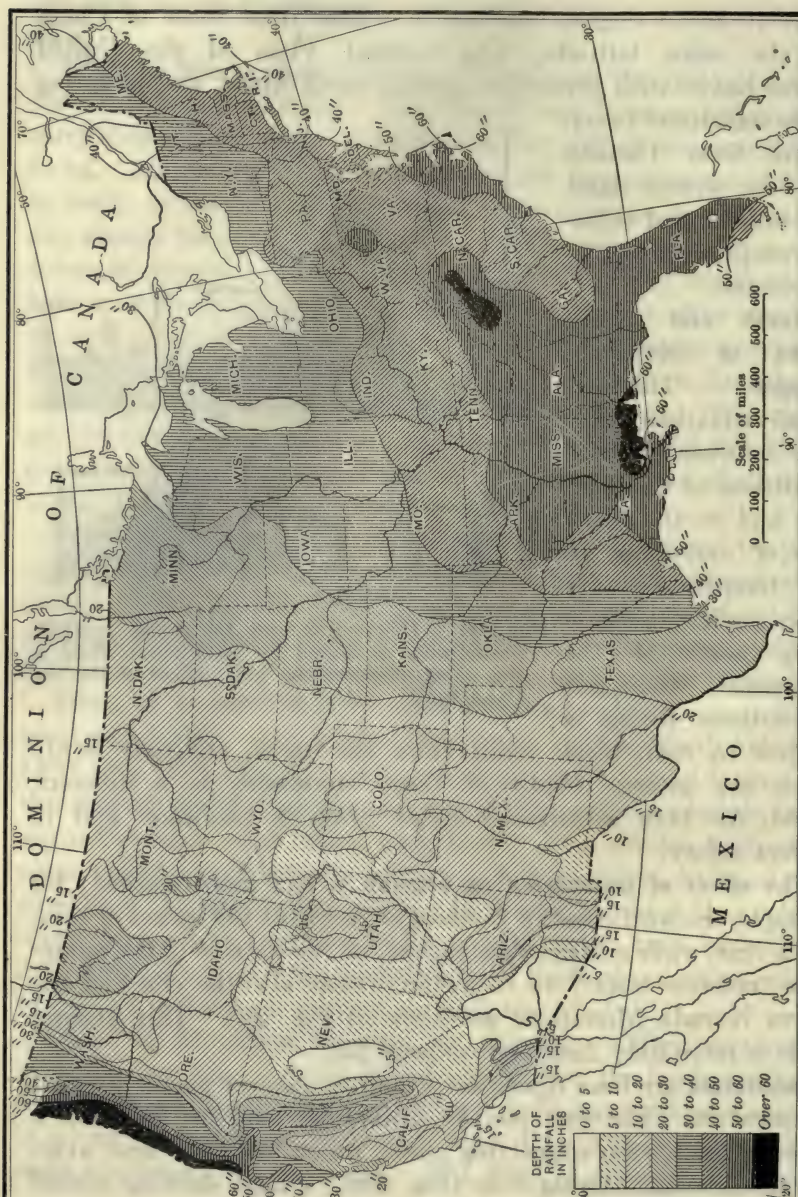


FIG. 207. — Average annual rainfall of the United States. (*After map by U. S. Dept. of Agr.*)

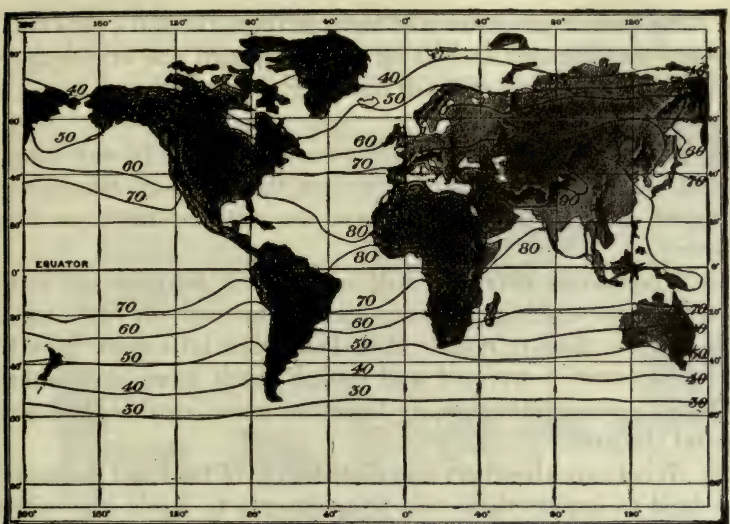


FIG. 208. — Isotherms for July. Note that the highest indicated temperature, 90° F., is found in the interiors of North America, Africa, and Asia. (*After Tarr.*)

isotherms has a series of lines each of which connects places having the same average temperature during the year.

SUMMARY OF THE GENERAL FEATURES OF CLIMATE

1. Climate is the average of weather.
2. Climate is determined by conditions that are more or less fixed, and so the climate of any part of the world changes very slowly; but there is ample evidence that great changes have occurred in past geological ages.
3. The three main elements of climate are temperature, moisture, and winds.
4. The four influences which most affect the climate of a place are latitude, altitude, nearness to the sea, and the direction of the prevailing winds.
5. Over 99 per cent of the heat which warms the earth comes from the sun.

6. The polar regions are cold because there the sun's rays traverse very slanting and hence long paths through the atmosphere, and also because fewer rays fall upon a given area than is the case in lower latitudes.

7. The earth is $2\frac{1}{2}$ million miles nearer the sun in our winter than in our summer, but in our winter the northern hemisphere is tipped away from the sun and so receives its rays very obliquely.

8. Temperature decreases with altitude (1° for each 330 feet). Mountain tops and high plateaus are cold because the rare atmosphere permits them to radiate their heat back into space rapidly.

9. The ocean is warmed and cooled much more slowly than the land; oceanic climates are therefore more equable than continental climates.

10. Winds are absorbers and distributers of heat and moisture; they tend to impart their own temperatures to lands over which they blow, and thus to make the lands warmer or colder, wetter or drier, as the case may be.

11. Cold or warm ocean currents affect the temperature of the winds that blow over them, and these in turn affect the climate of the land.

Climate and Man

Life in the Arctic. — It seems strange that anyone should care to live in a region of almost perpetual snow; yet 30,000 Eskimos and a number of other tribes live there. On a few occasions Eskimos have been brought to the United States, but they were unhappy and unhealthy and longed to get back to their northern home.

Seasons and "Days" in the Far North. — In the Far North, summer is the period of light, and winter the period of darkness. At the Arctic circle the longest period of continuous sunlight or continuous darkness is 24 hours; at 70° latitude, it is two months; at 78° it is four months, and at the poles it is six months.

Hammerfest, Norway, within the Arctic circle, is a city of 2250 people; they have 73 days of continuous daylight in summer and an

equal period of continuous darkness in winter. In northern Norway, Lapland, and Alaska beyond the Arctic circle a few hardy grains are grown. The reindeer has been domesticated and is the

FIG. 209. — The white winters of the Far North.

main dependence of the people. It is used as a draft animal; its milk and flesh furnish food; and its skin is used for clothing, blankets, and tents.

The uncivilized Eskimos of northern America represent a people who live the natural life of the Arctic zone. Their mode of life is in strict accord with their climatic environment, and therefore forms an interesting study in the effect of a cold climate upon the life and customs of people. The Eskimos are thus described by one who has visited them:

"The uncivilized Eskimos are spread in scattered settlements from just west of Bering Straits to the eastern coast of Greenland, fringing the mainland and also occupying the coast of some of the islands. Formerly throughout this area, and at present in those places out of reach of the influence of white men, the Eskimos have been engaged in one of the most serious struggles against adverse geographic conditions of any people in the world. . . .

"They must look out to the sea not only for the bulk of their food, but also for materials for clothing and shelter. Only by the hardest struggle, constantly kept up, and by the exercise of intelligence, energy, and ingenuity,

is it possible for them to maintain life amid such surroundings. Since the food supply is shifting and uncertain, it is not usual for them to have fixed homes; they must ever be ready to move from point to point when the food supply fails. Consequently, though not strictly nomadic, they are migratory within a narrow range.

"This necessary mode of life of the Eskimo places a distinct limitation upon the amount of property that can be accumulated, for anything in excess of actual needs must be left behind when the time for moving comes. The boat (kayak), which the men use in hunting, the large skin boat (oomiak), in which the women and children move the property from place to place, a few skins for cover and for tents, the clothing which they wear, and a few simple implements constitute the outfit of Eskimo communities. The winter home is of ice or snow, suitable not merely because of the abundant supply, but also because it is easily worked and quickly built into the igloo form, and because it furnishes the best of shelter against the Arctic cold. The summer home consists of a few skins thrown over upright supports, usually the bones of large animals, easily put together, easily taken down, and easy to transport. For fuel in winter the blubber of the seal or walrus suffices, and in summer little or no fuel is used, since meat is relished in the raw state.

"The boat is made of skin wrapped around a frame of bone or, where possible, of wood that has drifted ashore. The hunting boat, or kayak, is long and narrow and can be propelled through the water with great rapidity, this being necessary in the seal hunt. . . . The winter sled is also an ingenious contrivance made of bone, or wood and bone, fastened together with thongs, shod with bone or ivory, and attached to the dog team with sinew. . . .

"Under these conditions of life it naturally follows that there can be no large settlements, for success depends upon scattering, otherwise the food supply in a locality would soon be exhausted. . . . Such a life necessarily breeds hardiness, courage, cunning, and intelligent ingenuity; but both the severe struggle for existence and the necessary mode of life are adverse to the internal development of civilization."[1]

The continent of Antarctica is larger than Australia; it is deeply buried under snow and ice and is surrounded by the great Antarctic or Southern Ocean; it is far removed from the other continents and has no human inhabitants.

Life in the Tropics

Equatorial Lowlands. — Here snow never falls, frost never occurs; day and night are always about 12 hours long, and there is little dawn or twilight; thunder storms occur almost every afternoon in the wet season; a dense jungle usually covers the land;

[1] From "Human Life in the Arctic," by Professor R. S. Tarr, *Journal of Geography*, Vol. X, p. 145.

FIG. 210. — One of the ice palaces erected in Montreal in years past. Built entirely of blocks of ice. (*Physiography Lab. Cornell Univ.*)

insects are a pest and a menace; birds have gorgeous plumage; flowers are brilliantly colored; weeds are unconquerable; agriculture is discouraging; malaria, yellow fever, and other tropical diseases are prevalent; the native peoples are dark skinned, usually lazy, content to live on what nature provides, and disposed to produce little beyond their few simple needs. There are so-called wet and dry seasons, or even two of each, due to the migration of the doldrums with the sun north from the equator a few degrees and then south again. These regions have never produced a people or nation that contributed anything of importance to human advancement. Though the torrid zone includes a third of the land of the earth, it is practically all ruled by Europeans or descendants of Europeans. White men cannot live long at a time and retain their vigor in the equatorial lowlands.

Tropical highlands are cool, but the climate is likely to be monotonously uniform. Rainfall may be heavy or light, depending upon the direction of the winds. Quito, near the equator in Ecuador, is over 9000 feet above the sea; the mean temperature of its coldest month is only one degree lower than that of its warmest

FIG. 211. — In tropical Jamaica. Natives returning from market. (*Physiography Lab. Cornell Univ.*)

month, while the range of temperature from day to night is 20 times as great. A majority of the people of western America from Bolivia to Mexico live on the plateaus at elevations ranging from a mile to two miles above sea level.

The trade wind belts differ widely in different portions. Since the trades blow from cooler to warmer regions, their tendency is to absorb and not to precipitate moisture, and thus they are likely to produce deserts. Arabia and the Sahara and the deserts of Aus-

Fig. 212. — The dense vegetation of the humid tropics; the north shore of the island of Jamaica. (*Physiography Lab. Cornell Univ.*)

tralia and of South Africa are mainly in regions over which the trades blow. If, however, the trade winds, blowing from the sea, encounter mountains, as they do in Brazil and Central America, they bring rainfall, perhaps in great abundance; yet deserts are much more common than jungles in the trade wind belts.

The Savannas or Grass Lands. — Between the equatorial forests and the trade wind deserts there is usually an irregular belt which has a wet season followed by a very dry one. The Soudan, south of the Sahara in Africa, is such a region. In our summer, as the sun moves northward, the belt of equatorial rains moves northward over the Soudan, bringing to it the rainy season. Later, the equatorial rain belt moves southward, and the Soudan is then brought under the influence of the trades and the dry season follows. Under these conditions forests cannot maintain themselves, but grass grows abundantly. Regions of this type are called *savannas*. The *llanos* of Venezuela, the *campos* of southern Brazil, and the *park lands* of South Africa are savannas. They are used for pasturing cattle and sheep,

but have nowhere as yet attained importance as the home of progressive peoples.

Life in the desert is hard and the severe conditions strongly influence the habits and even the moral standards of the desert

FIG. 213. — Only parts of the desert are sandy. Much larger areas are bare rocks from which the sand has been blown.

people. Huntington, who has seen much of these people, has pointed out how the desert affects the Arab's views of right and wrong:

"No argument is needed to prove that the moral standards of the desert are vastly different from our own. What seems absolutely wrong to us may seem not only right but laudable to them. To what shall we ascribe this? There is ground for believing that many of the most prominent Arab traits have been caused, or at least fostered, by the hard conditions imposed by the desert climate.

"Consider what happens to an Arab nomad during the course of a year. In the spring, when the camels, goats, and sheep are giving abundance of milk he lays up a store of sour cheese and curds, dried as hard as the toughest hardtack. Then when the summer comes he exchanges his surplus animals,

chiefly the young males, for dates, wheat, and rice grown in the oases or in the border lands where agriculture is possible. A few animals may be saved for future use as food, but only the most wealthy can afford to eat meat often. In good years the ordinary Arab can lay by enough food to last himself and his family until the following spring. Suppose, however, that the year has been dry, and many of the young animals have died on the one hand, and the price of dates and wheat is high because the crop is scanty on the other hand. In that case a large number of the nomadic Arabs are unable to lay by food enough to last them later than perhaps February, the time when the rains ought to come and the young sheep and camels to begin to be born, and the milk to be abundant. . . . Imagine the state of people who eagerly pack their tents and all their crude belongings upon camels and travel one or two hundred miles simply because they have heard that a little shower has fallen over an area no larger than that watered by a single summer thunderstorm in America. Yet this is a common occurrence in Arabia. . . . What is an Arab to do when his camels, his sheep, his wife, his children, and himself are all suffering the pangs of hunger? He cannot go off to some other land and get work. . . . The only resource under such circumstances is plunder. The man who is starving has little thought of right or wrong. To have such thoughts would seem to him fatal. If considerations of humanity or any other moral ideas prevent him from engaging in raids upon the tribes around him, the doom of his family is sealed, or his children die of hunger. Thus through the thousands of years since Semitic nomads first lived in Arabia the hard conditions of climate have steadily weeded out all who withheld their hands from violence." [1]

Climates of the North Temperate Zone

Characteristics. — Considered as a whole, the climate of the north temperate zone has four characteristics: (1) *four seasons* — spring, summer, autumn, and winter; (2) *a very wide range of temperature* from the hottest to the coldest days, and from the hottest to the coldest places; (3) *winds prevailingly from the west*, yet constantly shifting; (4) the presence of *cyclones* and *anti-cyclones* (lows and highs) moving from west to east, and causing great uncertainty of weather.

West-facing Coasts. — It has been pointed out that west-facing coasts in the temperate zones have a more equable temperature than east-facing coasts. The former have the oceanic type of climate (equable) and the latter the continental type (variable). In latitudes below 40°, west-facing coasts have relatively *light*

[1] Ellsworth Huntington, in the *Journal of Geography*, Vol. X, pp. 172, 173.

FIG. 214. — Dense forest on the west coast of Washington where the rainfall is heavy and the winters mild. (*U. S. Geol. Sur.*)

rainfall, and this comes mainly in winter. In higher latitudes these coasts have heavy rainfall also chiefly in winter.

Climate of our Pacific Coast. — Southern California, from San Diego to San Francisco, has a great deal of sunny weather — 200 to 250 perfectly clear days a year — and in the south the temperature is that of almost continuous spring. The westerlies prevail in this region and three-fourths of the small annual rainfall comes in December, January, February, and March. In summer the northward movement of the sun brings the horse latitudes to southern California, and during the four summer months little or no rain falls. Freezing temperatures are rare; under irrigation, oranges, lemons, figs, and olives and all of the hardier fruits grow, and flowers bloom in gorgeous profusion.

In the vicinity of San Francisco the average rainfall is 23 inches a year; nearly all of it falls during the six winter months from No-

vember to April. June, July, and August as a rule are nearly rainless. The coast of California really has only two seasons, a wet and a dry. In summer, dense banks of fog roll in from the sea and inclose the city and bay, but the neighboring mountain tops rise above the billows of white fog and are bathed in brilliant sunshine. Though San Francisco is in the latitude of Washington, D. C., snow seldom falls and even a hard freeze is rare. The summers are cool and summer evenings are often too chilly for comfort. The average temperature of the warmest month is only 11 degrees above that of the coldest; contrast this with St. Louis in the interior of the continent, which has a range of 55 degrees between its warmest and its coldest month. The Great Valley of California has a light rainfall, and irrigation is extensively practiced. Climatic conditions are ideal for raising grapes, peaches, prunes, pears, apricots, and many other fruits. California produces more fruit than any other three states (Fig. 205).

Fig. 215. — Heavy rainfall of the Pacific coast due to the westerlies and the mountains. (*After Tarr.*)

Northward from San Francisco the yearly rainfall is increasingly heavier; in western Washington it reaches 140 inches, the highest in the United States, and continues to be heavy along the entire coast well into Alaska. The rain is heaviest in winter, while the summer months are relatively dry. This is due to the fact that in win-

ter the land is cooler than the ocean and hence the moisture-laden winds blowing in from the Pacific precipitate a great amount of rain on the windward or western side of both the Coast Ranges and the Cascades. Twenty times as much rain falls on the Olympic Mountains, near the Pacific coast, as falls in certain parts of the state east of the Cascade Mountains. In western Washington, Oregon, and northern California are found the most magnificent forests in the world (Fig. 214). So great is the tempering effect of the Pacific upon the west coast as far north as Alaska, that Sitka, 900 miles farther north than Halifax, Nova Scotia, has the same average temperature.

The Climate of Western Europe. — The warming influence of the Atlantic on the winter climate of western Europe is so great that the effect of the northerly latitude is largely offset. Ocean currents, especially the Gulf Stream, bring a great amount of heat into the north Atlantic; the westerlies absorb this heat and carry it over Europe. But if there were no Gulf Stream, the warming influence of the Atlantic would still be great. The British Isles and the coast of Norway have heavy rainfall and are as mild in winter as are our middle Atlantic states, which are from a thousand to fifteen hundred miles farther south. The west coast of Europe, like the west coast of the United States, has more rain in the north than in the south. The winter temperatures of much of Europe change more from west to east than from south to north. Rainfall also decreases steadily from west to east across Europe. The warming influence of the Atlantic is carried much farther into Europe than that of the Pacific is into North America because Europe has no high mountain barrier on its west side as North America has. The effect of the Atlantic upon winter temperatures in central Europe is shown by five rivers in Germany. Ice lies on the Rhine an average of 26 days in a year; on the Elbe, 62 days; on the Oder, still farther east, 70 days; on the Vistula, 86 days; and on the Memel, mainly in Russia, 116 days. In summer the ocean cools the winds that blow over west-facing coasts and give to the British Isles, for example, summers as cool as those of Newfoundland and Labrador.

FIG. 216. — Rainfall of the world. (*After Herbertson and Taylor.*)

Climate of the Interior of the United States. — With the exception of land near the Pacific, and scattered regions of high altitude, the western third of the United States is arid or semiarid. West of the 100th meridian the rainfall averages less than 20 inches a year, and ordinary agriculture is rarely successful in any region where the annual rainfall is below 20 inches. Large parts of the Great Basin, included in Arizona, New Mexico, Nevada, Utah, and parts of some other states, are true deserts, because rain-bearing winds blowing from any direction are intercepted by mountains. Throughout the Great Basin agriculture is largely (though not wholly) dependent upon irrigation.

The High Plains. — A tier of states from the Dakotas southward to Texas, the "high plains" states, have enough rainfall for crops nearly every year, but partial crop failures sometimes occur in the western part of these states on account of drought. However, dry-farming and the introduction of drought-resisting crops are helping to remedy these conditions and these states are producers of enormous quantities of cereals. This was once a grazing belt, the land of the cowboy. It is now our principal wheat-growing belt. Eastward from the 100th meridian the rainfall increases rather steadily to 30, 40, and 50 inches.

The Mississippi Valley is a region of great agricultural prosperity, nevertheless heavy losses are occasionally sustained from too much or too little rain. These losses may reach a total of hundreds of millions of dollars in a single year, but they are spread over so great a number of states that their effect is seldom disastrous.

Lying in the belt of cyclonic storms, the region is subject to rapid changes of weather and wide extremes of temperature. In the interior the summers are hot and the northern winters are severely cold. The temperature in the most northerly states may fall as low as 40° below zero and rise to 100° or higher. Throughout the interior, rain, largely derived from the Gulf of Mexico, is most frequent in spring and summer, a highly favorable condition.

The Gulf states rarely have snow and the growing season for plants (period between the last killing frost in the spring and the first in the fall) is from 7 to 8 months long.

Climate of the Eastern Coast of the United States. — This may be taken as a type of an east-facing coast in the region of the prevailing westerlies. The land immediately bordering on the Atlantic has a more equable temperature than the interior of the continent; but the influence of the ocean does not reach far inland because the prevailing winds come from the west. In the middle Atlantic states the wind blows from the western quarter three times as much as from any other quarter. The weather is exceed-

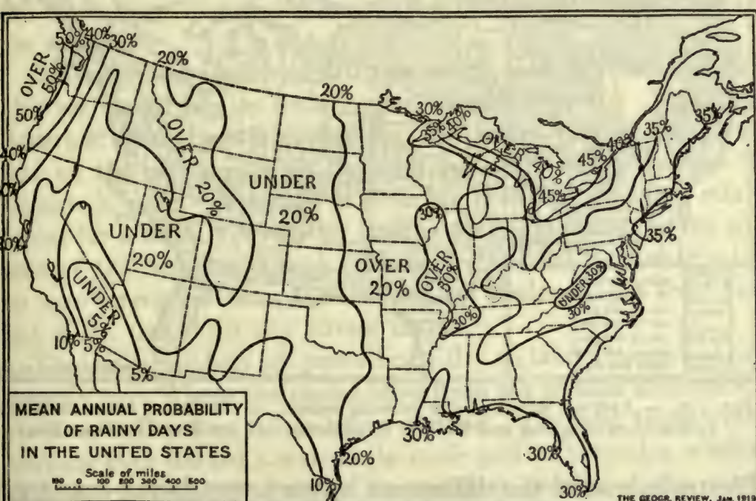


FIG. 217. — *(After Ward in the Geographical Review.)*

ingly changeable; the winters of New England and New York are severe and the summers are fairly hot. The frequent passing of cyclones along the northern storm tracks causes indrafts of moist air from the Atlantic and the Gulf of Mexico and gives the eastern states ample rainfall amounting to 40 to 50 inches north of Virginia and 50 to 60 inches south of that state.

From Florida to Maine the average temperature decreases rather steadily. For example, fruit trees blossom three weeks earlier in northern Delaware than they do 150 miles north, near New York

City. Recall that a distance of 500 miles north and south on our Pacific coast makes little difference in the average temperature, while a third of that distance along the Atlantic coast makes three weeks' difference in the time of blossoming of fruit trees. This

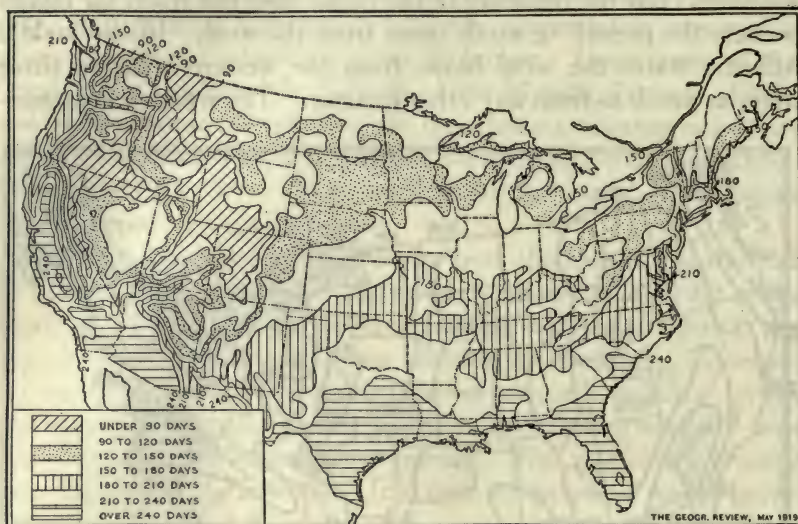


FIG. 218. — Average length of the growing season, or the period between the last killing frost in spring and the first in autumn. (*After Ward in Geog. Rev.*)

illustrates one of the differences between west-facing coasts with their oceanic climate and east-facing coasts with their continental climate.

Summary of Climate and Man

In the Far North the conditions of life are so hard and the struggle for existence is so unceasing that only a comparatively few people live there. Within the polar circles the longest period of light or darkness varies from 24 hours at the Arctic and Antarctic circles to six months at the poles. The Antarctic continent is larger than Australia but is deeply covered with ice and snow and has no permanent inhabitants.

The equatorial lowlands are regions of excessive rains and dense vegetation. The climate, always sultry and depressing, robs man of ambition; agriculture is an incessant fight against weeds. Sustained effort is disagreeable; work is irksome; thrift and forethought are not necessary to existence, and so are little practiced; thus, the native tribes would, of themselves, scarcely rise above barbarism. Tropical diseases make it dangerous for white men to continue long in these lowlands, which, as a result, remain, and are likely long to remain, among the most undeveloped parts of the earth.

In the tropical highlands, altitude offsets latitude, and an agreeable and healthful, yet monotonous, climate prevails. In western America, from Bolivia to Mexico, the larger part of the people live on the plateaus or in the high mountain valleys. Here the climate is cool — even cold in Bolivia; it is dry and fairly stimulating for a while, yet entirely lacking the tonic quality of the winters of the temperate zone. These regions are far better suited to man's progress than are the tropical lowlands, yet they have not given the world any strong nation.

The trade wind belts are prevailingly dry on land, though not necessarily so. Where the trades blow from sea to land and encounter mountains, they cause heavy rainfall. On land these winds, blowing ever toward a warmer latitude and so becoming warmer, take up moisture and cause the greatest deserts of the world, notably the Sahara and the Arabian Desert. The population of the desert is relatively small yet larger than is generally supposed. The oases are usually peopled with a settled population, but the desert tribes are nomadic and lawless. When they feel the pinch of hunger, as they often do, they turn robbers and marauders, attacking caravans and raiding other tribes. This trait of the desert peoples is so general that it has evidently been bred in them by the hard life of the desert.

The temperate zones are clearly the best suited to human progress. The four seasons have taught man the need of a season of sowing, a season of growth, a season of harvest, and a season of rest and recuperation. The cyclonic storms which are such an

important element in the weather are believed to stimulate mental and physical energy. In the temperate zones, as nowhere else, man has learned thrift, industry, efficiency, and the value of stable government. Here he has acquired the work habit and finds it agreeable. Here nature is not so generous in her gifts as in the torrid zone, yet she rewards effort much more abundantly than she does in the frigid zones. Here in the middle latitudes man finds the "happy climatic mean," and has reached his highest development. A few nations in the north temperate zone dominate the world's affairs, and the most progressive peoples of the southern hemisphere are those of the south temperate zone.

EXERCISE XX

Review Questions on Climate

1. Define climate.
2. How does climate differ from weather?
3. What evidences have we that in parts of the world the climate of the past differed from that of the present?
4. What are the most important elements of climate?
5. Upon what conditions does the average temperature of a place mainly depend?
6. What is the source of practically all of the heat that warms the earth?
7. Describe the way in which waves of energy from the sun yield light and heat.
8. Why are the polar regions cold and the equatorial belt hot?
9. Why are slanting rays from the sun less effective in heating the land than perpendicular rays?
10. Why do we not have summer when the earth is nearest the sun?
11. Why is the summer of the southern hemisphere not warmer than that of the northern?
12. Why do mountains usually receive considerable rainfall?
13. Why do high plateaus usually have a dry climate?
14. Explain how large bodies of water influence the climate of the adjacent land.
15. Point out the effect of the Great Lakes upon fruit-growing in their vicinity.
16. Why do oceanic islands have an equable temperature?
17. What are some of the important effects of winds upon climate? Give examples.
18. How do ocean currents influence climate? Give examples.
19. Explain how topography influences climate. Give examples.
20. How does topography influence rainfall?

21. How long is the longest "day" at the poles? at the polar circles? at 70° latitude? at Hammerfest, Norway?

22. Describe the conditions of life in the Far North.

23. What are the main features of climate in equatorial lowlands? in equatorial highlands?

24. Name some of the countries which include large areas of tropical lowlands; of tropical highlands.

25. Tell something of the conditions of human life in these regions.

26. Point out important ways in which climate affects people and their stage of civilization.

27. Why do the trade wind belts include much desert? Name and locate some of these deserts.

28. Under what conditions do the trade winds yield heavy rainfall? Give an example.

29. Where are the savanna belts? Why do they have alternate wet and dry seasons?

30. To what use are the savannas best suited? Why are they sparsely populated?

31. What are the main characteristics of the climate of the north temperate zone?

32. Describe the principal features of the climates of the Pacific coast of North America.

33. Account for the peculiarities of the rainfall of different parts of that coast.

34. Why is fruit-growing highly successful in California?

35. Account for the dense forests of western Washington and the dryness of eastern Washington.

36. Why is the winter temperature of the coast of Alaska milder than that of the coast of Labrador?

37. Account for the mild climate of the British Isles and of the coast of Norway.

38. Why does the interior of the United States have such changeable weather and such a wide range of temperature?

39. In what parts of the United States is rainfall ample for the needs of agriculture? In what parts is it inadequate?

40. At least how many inches of rainfall are needed for ordinary agriculture in the United States?

41. Why is the grazing of cattle or sheep extensively practiced in lands having low rainfall?

42. Name some crops which are especially sensitive to cold.

43. From what bodies of water is the rainfall of the central United States mainly drawn?

44. Why is there a much wider variation in temperature along our Atlantic coast than along our Pacific coast?

CHAPTER XVI

THE OCEAN AND ITS SHORES

Extent of the Ocean. — The ocean waters cover about three-fourths of the surface of the earth. This is quite in contrast with the moon, which has no oceans, and Mars, our nearest neighbor among the planets, which has none so far as can be discovered. The proportion of land and water surface on the earth undergoes a slow change. At one time or another shallow ocean waters have covered almost every part of the continents as the sea-laid sedimentary rocks show. If the earth were a perfectly smooth globe, the ocean waters would cover its entire surface to a depth of 1.7 miles. Instead of being smooth, however, the surface of the earth has broad depressions, and in these the ocean waters collect. There is more than sufficient water to fill them, and so the ocean spreads over nearly 10,000,000 square miles of low land along the borders of the continents (Fig. 2). Unlike the continents, the oceans are all connected; they really form one great body of water, but it is convenient to have names for the different portions, and so we speak of the Atlantic, Pacific, Indian, Arctic, and Antarctic oceans.

The Ocean Basins. — The deepest known part of the ocean is over 32,000 feet, or a little over 6 miles (near the Philippine Islands). Since, in this latitude, the Pacific is over 6000 miles broad, the greatest depth is only $\frac{1}{1000}$ of the width. A fine hair-line drawn across this page would be too thick in proportion to its length to represent the comparative depth and width of the Pacific, or any of the other oceans. However, the ocean basins dip below the level of the sea more than the continents rise above that level. If all the land which is above sea level were scraped off

FIG. 219. — The rocky New England coast. (*Courtesy of B. & M. R. R.*)

and dumped into the ocean basins, it would not go far toward filling them.

The ocean bottom is for the most part a plain. Near the continents and oceanic islands steep slopes occur, but since no streams are eroding valleys under the sea, and since sediments are being constantly deposited on the ocean bottom, it is a vast and monotonous plain. There are, of course, great sags and swells, over which the water is deeper or shallower as the case may be, and some of the "deeps" have quite abrupt slopes; yet the steepest of these are much less abrupt than those on land. A broad swell, or ridge, extends north and south through the mid-Atlantic, reaching in places within a mile or less of the surface of the sea. Chains of islands, such as the Japanese Islands or the West Indies, are mountain chains rising from the sea floor; the islands are the higher portions of the mountain chain, while shoals are the elevations which do not quite reach the surface.

Ocean Bottom Deposits. — Near the shores of the continents, rivers are dumping sand, silt, and clay into the sea, and the shore currents and tides are distributing these over the sea bottom near the coasts. Only the finest

of the river-brought sediments are carried more than a few hundred miles out to sea. Most of them are deposited on the continental shelf, as the submerged margin of a continent is called.

Somewhat less than half of the ocean is two miles or less in depth, and this portion is covered with an ooze formed mainly of the skeletons of microscopic creatures. More than half of the ocean is over two miles deep, and here the sea-bottom sediments form a peculiar red clay made up of those parts of the tiny skeletons which do not dissolve. These last-mentioned sediments accumulate very, very slowly.

FIG. 220. — Coral growth, low tide. (*Field Museum.*)

Composition of the Ocean Water. — The rivers carry dissolved mineral matter to the sea, and, as the ocean waters are evaporated by the sun and wind, this dissolved mineral matter is left behind in the ocean. Two of the minerals dissolved in the sea are common salt and carbonate of lime. The latter is taken up by animal life and used in making their shells and skeletons. The corals, for example, extract lime from the sea and build coral reefs of great extent (Fig. 220). The salt is not much used by sea life and so it

accumulates age after age; the ocean now contains enough salt to make a layer 175 feet thick over its entire bed. Many other kinds of dissolved mineral matter are found in the sea, the total forming about $3\frac{1}{2}$ parts to each hundred parts of water.

Temperatures of the Ocean. — Under the same conditions the land heats and cools about four times as rapidly as the sea, and so the temperature of the ocean varies from season to season much less than that of the land. In any one place the ocean temperature seldom varies more than 10 degrees during the year, while land temperatures often vary more than ten times that amount. In the equatorial region the surface of the sea averages about 80° F. In the inclosed Red Sea the surface temperature may rise to 90° or even higher. In the polar regions the temperature is as low as 28° F., at which point salt water freezes. Proceeding from the equator toward the poles, the temperature of the ocean does not decrease uniformly. In some places warm currents or drifts reach far toward the poles, and elsewhere cold currents from high latitudes reach far into the temperate zones (Fig. 222). As a rule the ocean becomes colder with increasing depth, but below 4000 feet the temperature is found to be between 35° and 40° F., and at the greatest depth to be below 35°. Only in the frigid and in the very cold parts of the temperate zones does the ocean water freeze. Nearly all the ports on the west side of North America and Europe are open throughout the year; those in North America from the Gulf of St. Lawrence southward never freeze.

The *great amount* of ocean surface, and the comparatively slight change in ocean temperature from season to season have a most beneficial effect upon the earth's climate. Were it not for this influence of the ocean, the extreme temperatures on land in the temperate zone would be almost, if not quite, unbearable.

Life in the Ocean. — Air, which is necessary to plant and animal life, is dissolved in the ocean water, but it is mainly confined to the upper portion. Light in only a small amount penetrates below 300 feet, hence plants or animals requiring light cannot live at a depth much greater than this; but a little plant life is found down to depths of 1000 feet. While there are microscopic creatures in every part of the sea, most of the life is found in the uppermost 300 feet of water. Some life exists even in the deepest water, but it is exceedingly scanty in the intermediate portions, that is, between the bottom of the sea and the 300 feet at the top. At great depths the pressure is enormous, and fish which live there are especially constructed to resist this pressure. When caught and raised to the surface they sometimes burst or "explode." Some of the deep-

sea fish have eyes and some have none, and many species of sea creatures are phosphorescent; that is, they emit a light somewhat like that given out by the head of a match when it is slightly rubbed in the dark.

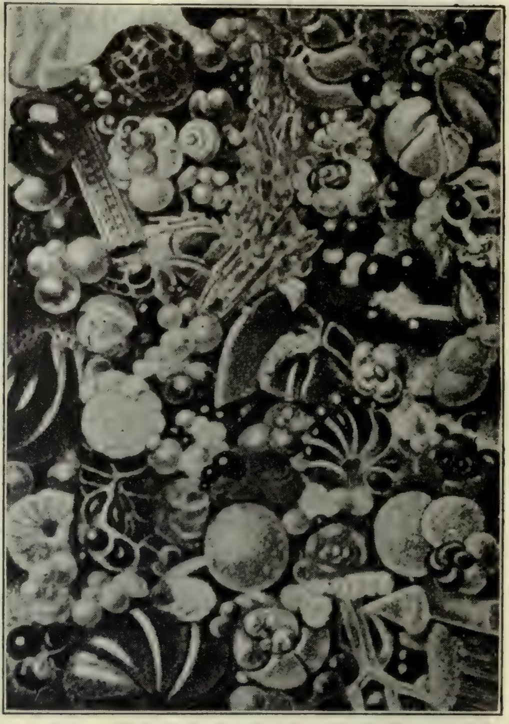


FIG. 221. — Magnified skeletons of minute creatures that make up the ooze on portions of the sea bottom. (*Field Museum.*)

The animal life of the sea is almost endless in variety; it includes the largest existing animal, the whale, and many others of large size, such as seals, sea lions, and walruses. Most forms of animal life in the sea extract lime carbonate from the water and with it build their own skeletons or shells. Conspicuous among them is the tiny coral polyp which lives in colonies of millions and builds coral reefs sometimes hundreds of miles in extent. The limestone rocks which cover large areas of the earth are largely composed of material collected and deposited by animal life in the sea.

Food from the Sea. — It is estimated that man obtains at least \$500,000,000 worth of food from the sea each year; this is largely made up of oysters, clams, lobsters, cod, mackerel, herring, and many kinds of fish caught near shore or in the shallow waters like the North Sea, or on the so-called fishing-banks, like those south of Newfoundland.

Movements of Ocean Waters

Wind Waves. — As the wind blows over the water, the friction of the moving air upon the surface of the water heaps it up into waves, the size of the wave depending upon the violence of the wind. The *wave form* moves forward with the wind, but the movement of the water in the wave is mainly up and down, as may be seen by observing a floating piece of wood. Some of the surface water is dragged forward by the wind, although far more slowly than the wave itself progresses. Upon reaching shallow water near shore, the bottom of the wave is retarded by friction upon the sea bottom and the top of the wave tumbles forward, forming white-crested breakers.

Ocean Currents. — Wherever the wind blows more or less constantly over the ocean in one general direction, the surface water is set in motion in the same direction and a surface current or drift is produced. These are by no means so well defined as the map (Fig. 222) seems to indicate. In most cases they are to be thought of rather as slow drifts of surface water than as distinct currents.

The Equatorial Currents.—In both the Atlantic and Pacific oceans the trade winds produce westward-moving currents on each side of the heat equator, while between these is a return current moving eastward (Fig. 222).

The Gulf Stream. — The equatorial currents of the Atlantic divide as they approach the wedgelike nose of South America. The northern branch flows through the Caribbean Sea, whence part of it passes northward by way of the West Indies, and part enters the Gulf of Mexico. A large amount of fresh water also flows into the Gulf from rivers. The water that flows through the narrow strait between Cuba and Florida and thence in a northeasterly direction is known as the Gulf Stream. As it leaves the Strait of Florida it has a velocity of 5 miles an hour, is 50 miles wide, and occupies the entire channel. For hundreds of miles its course through the Atlantic can be noted by the warmth, color, and motion of its water. Some distance out from the strait, the Gulf

FIG. 222. — Ocean currents of the world. (*Tarr and McMurry.*)

Stream is joined by the warm water which has come from the equatorial region by way of the West Indies (Fig. 222); before the mid-Atlantic is reached, the "stream" has spread out more and more fanlike, its rate of movement continues to diminish and it merges into what is known as the North Atlantic Drift, with a movement of only 8 or 9 miles a day. So much heat is thus carried into the North Atlantic that Norway, in the latitude of Greenland, has a fairly mild winter climate and its ports are never frozen; the British Isles are as mild in winter as Maryland, 1400 miles farther south.

The Labrador Current (Fig. 222), and other return currents both at the surface and below, carry back toward the equator the water which drifted north in the Gulf Stream and North Atlantic Drift. The Labrador Current flows close to the coast of Labrador, Newfoundland, and Nova Scotia, and exerts a cooling influence on the Canadian and New England coasts. Near Newfoundland it encounters the warm North Atlantic Drift, and the mixing of the cold and warm air over these waters causes dense fogs, which are dreaded by navigators, particularly on account of the gigantic icebergs that float south in the Labrador Current.

Currents of the Pacific. — The Pacific has its equatorial currents, its Japan Current which corresponds to the Gulf Stream of the Atlantic, and its west wind drift. The Japan Current is less distinct and less important than the Gulf Stream. The North Pacific drift of warm water imparts its temperature to the westerly winds and they give a mild oceanic climate to the Pacific coast of North America; but because of the mountains near the Pacific coast the oceanic influence is not carried so far into North America as it is into Europe from the Atlantic.

The Currents of the Southern Hemisphere are less important than those of the northern, mainly because the oceans of the northern hemisphere are used more and because the northern continents are larger and more populous than the southern. The position and direction of the currents of the southern hemisphere are shown in Fig. 222.

Causes of Ocean Currents. — The close agreement between the direction of the prevailing winds and that of the principal ocean currents and drifts leaves no room for doubt that these winds are the main cause of the currents. Yet they are not the sole cause. Wherever the wind forces the water to move away from any portion of the sea, other water flows in to take its place, and thus an extensive and complex circulation is set up. There are also other causes for the circulation of ocean waters, such as unequal heating, differences in salinity, and the inflowing of rivers. The direction of the main currents is determined not only by the direction of the prevailing winds, but also by the earth's rotation, and by the shape of the continents.

Tides. — An observer at almost any port may note that during periods of about 6 hours each day the water rises, and during following periods of about 6 hours it falls. This rising and sinking of the water is known as the *tide*. During the rising or incoming movement the tide is said to *flow*, and the highest water is called *flood tide;* the outgoing or receding movement is *ebb tide*. There are ordinarily two flood tides and two ebb tides every 24 hours and 52 minutes.

Cause of Tides. — This rising of the tide is due mainly to the attraction of the moon and also in a lesser degree to the attraction of the sun upon the ocean waters. Though the moon is much smaller than the sun, it is only $\frac{1}{400}$ as far away from the earth, and this makes it more effective in producing tides. When the sun, moon, and earth are about in a straight line, and so are pulling together, the highest tides, called *spring tides*, are produced (Fig. 223); and when the sun and moon are about at right angles and so are pulling in different directions, the lowest, or *neap tides*, are produced (Fig. 224). Not only does the moon's (or sun's) attraction cause a tidal wave on the side of the earth which is toward the moon (or sun) but it also causes one on the opposite side of the earth, a fact which cannot be adequately explained in a simple way, and is not here attempted. Since there are always tidal waves or "bulges" on opposite sides of the earth, and since the earth rotates daily upon its axis, a point on the coast is visited by both of these

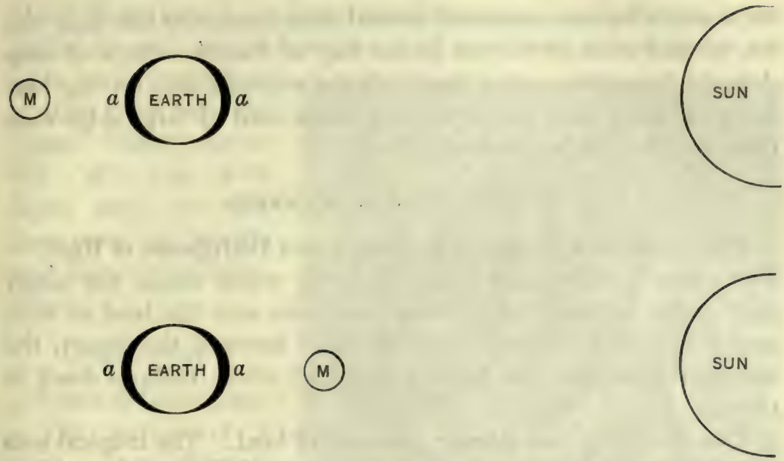


FIG. 223. — Showing the relative positions of sun, moon, and earth at spring tide. The black portion of the earth represents the tide, very greatly exaggerated in depth.

FIG. 224. — Showing the relative positions of sun, moon, and earth at neap tide. The moon may occupy either of the two positions shown, but, of course, not both positions at one time.

tidal waves every 24 hours and 52 minutes, the time from moon-rise to moon-rise.

Height of the Tide. — In the open sea, the average difference between high and low tide is only about 2 feet, but in V-shaped

bays which become narrower toward their heads the tide may rise 10, 20, and even 50 feet, as in the Bay of Fundy. Ships of deep draught frequently select flood tide for entering and leaving harbors. Indeed, many harbors could not be used by large ships were it not for the assistance of the tides.

The Ocean and Mankind

The Ocean as a Source of Rainfall and a Distributer of Heat. — The ocean is the source from which the winds obtain the larger part of the moisture which they distribute over the land as rain, and it is rain that makes the difference between the desert, the semiarid land, and the fruitful farmland where millions dwell in plenty.

The ocean is a vast storage reservoir of heat. The tropical seas absorb the sun's heat throughout the year, and those of the temperate zone absorb it in summer. By means of the ocean currents this heat is carried into colder latitudes and distributed over the land by the winds.

The Oceans as Barriers and as Boundaries. — Up to a few centuries ago the oceans so effectively separated the Eastern continents from the Americas that the Old World knew nothing of them. For ages the oceans were the most impassable barriers that man encountered. They are no longer barriers to man, but they are still the most satisfactory of all boundaries for nations.

Service to Commerce. — In this age of steam navigation, the oceans are of great benefit to commerce between widely separated parts of the world, because of the cheapness of ocean transportation as compared with land transportation. For example, the cost of shipping wheat from Chicago to New York by rail is from ten to twenty times as much per mile as it is from New York to Liverpool by steamer. The amount of wool needed to make a suit of clothes can be sent (in large shipments) from Australia to England, a distance of 12,000 miles, for four cents.

Relation to Wars. — The danger of war between any two nations is very greatly lessened if they or their possessions are separated by a broad stretch of ocean. With the single exception of the

World War, the only serious wars with foreign powers in which the United States has ever been involved have been with nations near us or having territory on this side of the ocean. There was no talk of war with Japan until we took possession of islands near Japan (the Philippines).

Fig. 225. — Sinking coast of a mountainous region; mountains become headlands and islands. A coast somewhat like that of Maine. (*Model by Davis and Curtis, Harvard.*)

Coast Line

Types of Coast Line. — The nature of a coast line depends upon the configuration of the land along the shore and upon the rising or sinking of the coast. The land has long been subjected to stream erosion and so is cut up into hills and valleys, but the near-by sea bottom has been undergoing an opposite process; it has become smooth by the deposition of sediments over its surface.

Sinking Coast. — If the land along the coast sinks, the sea backs up into the mouths of the creeks and rivers, while the hills or mountains stand up as headlands or islands extending out into the water. If the coast land is hilly or mountainous, as it is in Maine or southern Alaska, a very irregular, jagged coast line is produced, and if the sinking is considerable, river mouths become deep bays (Figs. 225, 226).

If a low, nearly flat coastal plain sinks, the shore line becomes swampy; the river mouths become broad, shallow estuaries, as they are along the coast of our south Atlantic states; deep harbors are rare or absent, and sand bars readily form parallel to the shore.

FIG. 226. — Map showing the submerged channel of the St. Lawrence River across the continental shelf.

Fiorded Coasts. — Norway presents the best example of this type of coast (Fig. 227). It is a region of rugged mountains with deep, stream-cut valleys leading down to the sea. During the Ice Age glaciers moved down these valleys and greatly deepened them by ice erosion. A sinking of the coast possibly accompanied this, and when the glaciers melted away, the ocean entered the long, narrow valleys, forming fiords (Fig. 228). Some of these extend from 50 to 100 miles into the land; the water is often hundreds of feet deep, while the precipitous cliffs rise high above the water's edge, and thousands of islands fringe the coast. Such coasts, found only where glaciers have been, occur also in southern Chile, in southern Alaska, in British Columbia, in Labrador, and in New Zealand.

FIG. 227. — A portion of the coast of Norway with its many islands and long fiords. Such a coast line is due to (1) river erosion, followed by (2) glacial erosion and (3) probable sinking of the coast.

Rising Coasts. — When a coast is uplifted without being deformed, a strip of sandy sea-bottom is added to the land and forms a low, flat coastal plain, lacking in natural harbors, such as the coast of New Jersey. If mountain ranges are uplifted near the shore, then a mountain coast such as that of western South America and Mexico, and parts of Italy is produced (Figs. 229, 230). Along such a coast there is little or no coastal lowland, and very few good harbors, making entrance into the continent from the sea more or less difficult.

The Ever Changing Character of Coasts. — Not only are coasts subject to rising and sinking, but they are constantly battered by waves and eroded by tides and shore currents. Headlands are worn off and little indentations are filled with sand or have sand bars built across their mouths. The tendency is for coasts to become more and more regular as time goes on, provided a sinking of the coast does not take place (Figs. 232, 233, 234).

The Influence of Coast Line. — Europe has the most irregular coast line of any of the continents, and Africa has the most regular. Europe also has the highest civilization and Africa the lowest; this is due in part to the difference in the coast lines of the two continents, though difference in climate has been a still more important

FIG. 228. — Hardanger Fiord, one of many along the mountainous coast of Norway. (*Physiography Lab. Cornell Univ.*)

FIG. 229. — The mountainous coast of Italy near Amalfi. (*Courtesy W. H. Dudley.*)

FIG. 230. — The rugged Italian coast south of Naples. (*Courtesy W. H. Dudley.*)

factor. The many peninsulas and indentations of the European coast have given it an exceedingly long shore line, with many points at which it can be entered from the sea. On the contrary, explorers, traders, and travelers have found Africa difficult to penetrate. Thus, Europe constantly received civilizing influences from the outside, whereas Africa did not.

The indented coast of Britain has favored the development of maritime people, and the remarkably indented coast of Norway has played an important part in the history of that country. The Vikings of the Norwegian coast were for many centuries the bold rovers of the northern seas, and Norway is to-day one of the leading maritime nations. The coast of Greece has many indentations, peninsulas, and islands; as a consequence the Greeks have long been the leading maritime people of the eastern Mediterranean. The influence of the coast line of the United States is discussed in Chapter XVII.

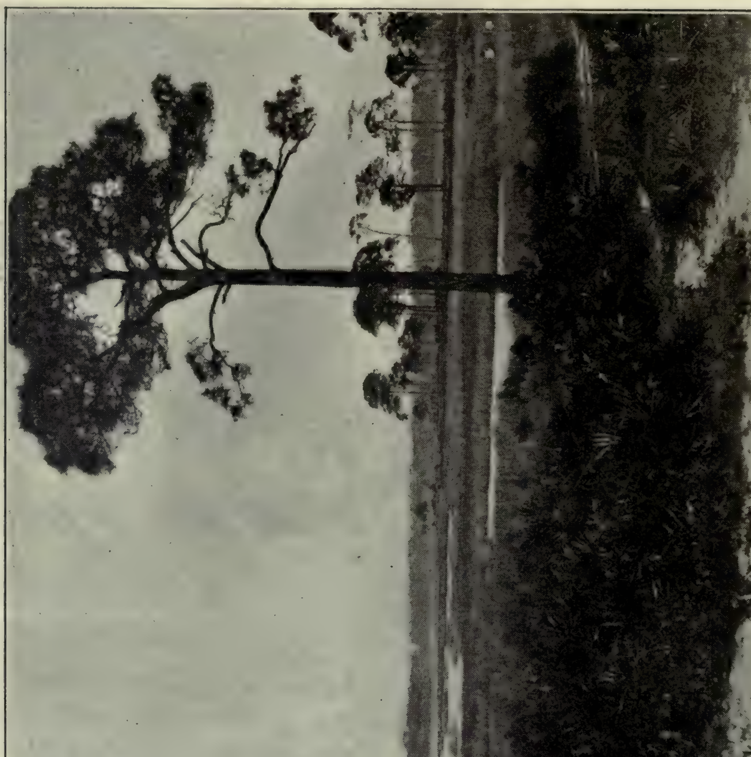


FIG. 231. — Example of the low, tidal marsh lands on the edge of the coastal plain of the southern states. (*U. S.*

FIG. 232. — A rocky, wave-cut coast, Oregon. (*U. S. Geol. Sur.*)

FIG. 233. — A specimen of New England's granite-ribbed coast. (*Courtesy B. and M. R. R.*)

Harbors

Qualities of a Good Natural Harbor. — Many harbors that once served well the needs of ocean commerce are too shallow for the great ships of the present day. A good modern harbor needs (*a*) to be deep enough for the largest ships to reach the piers (30 to

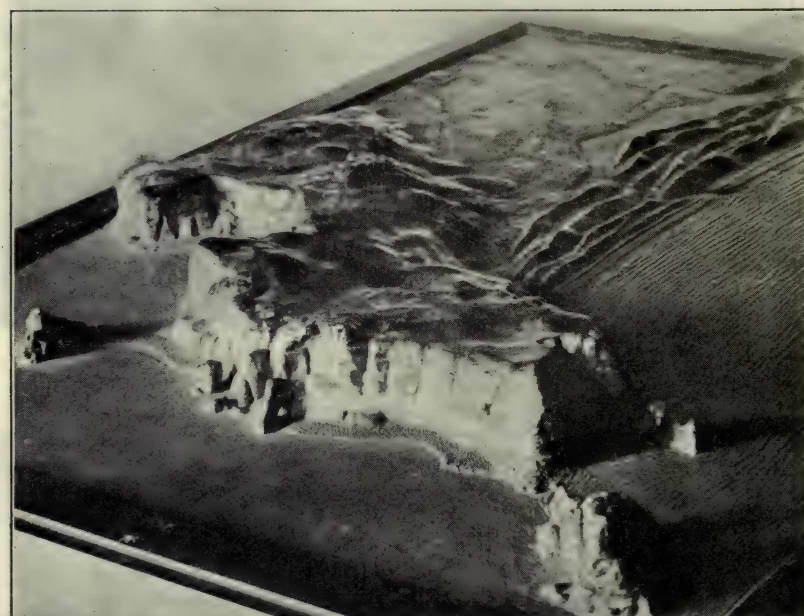


Fig. 234. — An island that is being slowly eaten away by the attacks of the waves.

40 feet deep near shore); (*b*) to be spacious enough to afford anchorage for many ships at one time; (*c*) to have a long water front, permitting many piers, warehouses, grain elevators, coal docks, railway terminals, etc.; (*d*) to have a deep and direct entrance channel; (*e*) to be well inclosed by land, giving protection from storms; (*f*) to have an easy route leading into the back country or "hinterland"; (*g*) to be free from ice obstruction the year around; (*h*) to be free from excessively high or low tides; (*i*) to be located

in a part of a continent where land and water routes naturally and conveniently meet.

The Improvement of Harbors. — There are few if any harbors which meet without improvements the needs of modern commerce. The great majority of harbors are the drowned mouths of rivers. The rivers deposit silt, and shore currents build sand bars across the channels, so that harbors require almost continuous dredging to remove the sediment. For example, the port of Liverpool requires the constant service of from five to seven powerful dredges. They remove annually about 20,000,000 tons of sand, equivalent to 500,000 car-loads. Piers, docks, machinery for loading and unloading ships, lights, railway terminals, and many other conveniences and necessities make up the equipment of a modern port of entry. (See description of New York Harbor, page 344.) It has cost the port of Glasgow more than $100,000,000 for improvements, and the port of Liverpool has expended $200,000,000 on docks. In some cases a harbor is so poorly protected against storms that an artificial wall, or breakwater, has to be built.

Summary

The earth, unlike the moon or Mars, possesses a large volume of water — enough to fill the great basins or depressions in the crust, and to submerge about 10,000,000 square miles of lowland belonging to the continents.

The greatest known depth of the ocean is over 6 miles, yet even the Pacific is a mere film of water when its depth is compared with its length and breadth. The ocean bottom is a monotonous plain with broad swells, and occasional "deeps," but with few steep slopes.

The salt, lime carbonate, and other minerals in sea water are mainly carried there by rivers. The lime carbonate is used by animals, large and small, in building their shells and skeletons, but the salt remains in the sea and slowly increases in amount as the sea water is evaporated.

The temperature of the sea is much more steady than that of

the land; it seldom changes more than 10° F. in any one place during the year. Since light does not penetrate much beyond 300 feet into the sea, the greater part of the life of the ocean is found in the more shallow waters and near the surface, but some life is found in all parts.

The three principal movements of the ocean are (1) waves caused by the wind; (2) ocean currents and drifts, which are largely due to the prevailing winds, and (3) the tides which are caused by the attraction of the moon and sun, the moon being the more important because of its nearness to the earth.

The north and south equatorial currents in both the Atlantic and the Pacific are due to the trade winds. The Gulf Stream is the most important of all the ocean currents. In the mid-Atlantic, it spreads out broadly and becomes the North Atlantic Drift. The mild climate of western Europe is partly due to the heat which is derived from this drift of warm water. The Japan Current in the Pacific corresponds in position to the Gulf Stream, but is less important.

The tide ebbs and flows twice in 24 hours and 52 minutes. Spring tides (high) are due to the combined attraction of the moon and sun. Neap tides (low) occur when the sun and moon are about at right angles to each other.

The great extent of ocean surface supplies the winds with abundant moisture and gives sufficient rainfall for crops to more than two-thirds of the land. If the earth had less ocean and more land, deserts would be increased. The great amount of ocean water has a tempering effect upon the climate of the earth as a whole. Ocean currents carry an enormous amount of heat from the torrid zone into higher latitudes.

Speaking generally, a sinking coast is irregular and may have many harbors. A rising coast usually gives a low coastal plain with few good harbors. Irregularity of coast line is favorable to intercourse between land and sea; this leads to trade, to the exchange of ideas between different lands, and to the general advance of civilization.

There are eight or ten desirable qualities of a first class natural

harbor. No single harbor possesses all of these, and even the best harbors require constant attention and expensive improvements.

EXERCISE XXI

Problems

1. Suppose, through a gradual sinking of the ocean bottom, the ocean basins were to become considerably deeper than they are now, what change would this make in the area of the continents? Name parts of certain continents which would show the change most.

2. Rivers carry more lime carbonate to the sea than they do salt, yet there is far more salt in the sea water than there is lime carbonate. Account for this.

3. Ports on the east coast of North America and of Asia are closed by ice when more northerly ports on the west side of North America and of Europe are open all the year. How do you explain this?

4. If a cubic foot of sea water weighs 64 pounds, what is the pressure on a square foot of ocean bottom at a depth of 5 miles?

5. Why is most of the fishing in the sea confined to the so-called "banks" or to other shallow waters?

6. Why are waves on the ocean larger than those on lakes?

7. What are (*a*) white caps and (*b*) breakers? What causes them?

8. Suppose the earth rotated on its axis from east to west; describe the probable movement of ocean currents in the Atlantic Ocean.

9. Suppose the Caribbean Sea were connected with the Pacific at Panama by a strait 100 miles or more wide. Point out any effect that this might have upon the climate of Europe.

10. The prevailing winds are believed to be the main cause of the ocean currents, yet no such wind accounts for the Labrador Current. How do you explain this current?

11. Both fogs and icebergs are more common near Newfoundland than elsewhere along the North Atlantic steamship routes. Explain why.

12. The winds blowing from the Pacific are of much less importance to North America than those from the Atlantic are to Europe. Account for this.

13. Why do ship captains need to know the time and height of tides in harbors which they visit?

14. Suppose the earth's surface were half land and half water, thus doubling the present amount of land; would this necessarily mean that the world could support twice as many people as it can now? Explain.

15. Give reasons why long-distance transportation on the ocean is cheaper than on land.

16. Why are nations that are separated by the ocean less likely to get into war than nations whose territories touch? Give illustrations from history.

17. If a hilly or mountainous coast sinks, the resulting coast line is likely to be very irregular. Explain why.

18. The Norwegians have been excellent seamen for centuries; but the Swedes who live in the same peninsula are not especially given to a sea-faring life. Account for the difference.

19. Why are rising coasts likely to be deficient in good harbors?

20. Maine has harbors equally as good as New York Bay, but they are of far less importance to overseas commerce. Explain why.

CHAPTER XVII

THE COAST AND COASTAL ACTIVITIES OF THE UNITED STATES

General Character. — The coast of the United States is highly favorable to the needs of a commercial nation:

(*a*) because of its great length;
(*b*) because of its many harbors;
(*c*) because it faces the two principal oceans.

Speaking broadly the coast is of three types:

1. the drowned and much indented coast of New England;
2. the coastal-plain shore of the middle and southern states;
3. the mountain coast of the Pacific.

1. From eastern Maine to New York Bay the coast has sunk so much that the sea entirely covers the coastal plain, and backs up into the valleys of all the streams flowing into the sea. Since this downward movement of the coast occurred, a lesser upward movement has taken place.

2. From New York southward around Florida and on beyond the mouth of the Rio Grande, extends a coastal plain; here the sea meets the land along a low, flat shore, with the characteristic features of a rising coast. Since the general uplift of the coastal plain, a slight sinking has occurred, changing the river mouths into broad but not deep estuaries and bays, of which Delaware and Chesapeake bays are examples.

3. The Pacific coast has practically no coastal plain, and the mountain ranges, which are very close to the sea, are broken by only three or four openings which make harbors suitable for ocean commerce.

THE ATLANTIC COAST

Favorable Features. — 1. The Atlantic coast is a much indented, many-harbored coast, especially from Virginia northward.

2. It is bordered by lowlands, in part suited to agriculture and

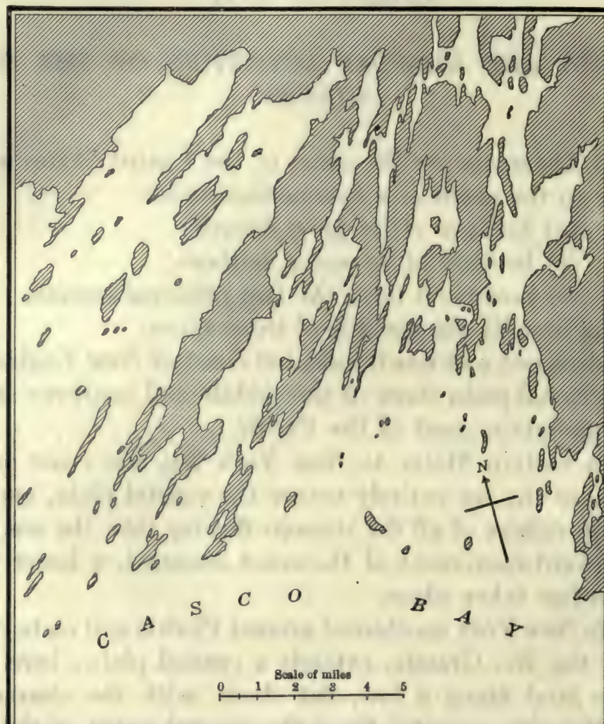


FIG. 235. — A part of the coast of Maine, showing the effect upon the coast line produced by the sinking of a rugged coast.

affording ample space for manufacturing centers, railways, and commercial cities.

3. The mountains (the Appalachians) which lie between the coast and the interior are easily crossed.

4. It faces Europe, the most important of the continents.

The Coast of Maine. — Maine is sometimes called the "Hundred Harbor State." The actual length of the coast is more than ten times the length measured in a direct line. The river valleys which lead down to the sea have been scoured and deepened by

FIG. 236. — Boston Harbor and surroundings.

glaciers, and a sinking of the land has drowned the river mouths, causing the sea to extend up the valleys, and leaving ranges of hills protruding into the ocean as headlands and islands (Fig. 235).

Maine's geographical position is somewhat isolated, and its many harbors, of which *Portland* is the most important, are less

used commercially than they would be if they were farther south. In the days of wooden ships the coast of Maine was famous for shipbuilding, and several ports, *Bath* in particular, still have important shipyards. A coast like that of Maine develops in its people a fondness for the sea, for ships, and for the seaman's life. Some 7000 fishermen still go out from the fishing villages and ports of Maine, and the annual catch reaches millions of pounds.

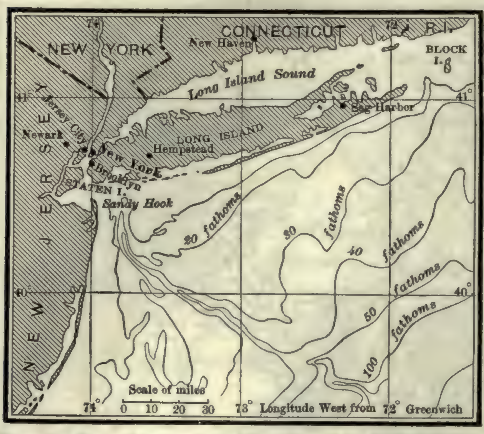


FIG. 237. — Map showing the drowned mouth of the Hudson River. The contour lines show the submerged channel across the continental shelf.

The wild beauty of the Maine coast, its cool summers, its green islands and blue waters, attract thousands of people who go there for health, rest, and pleasure. The coast of Maine has become one of the nation's summer playgrounds.

Boston Harbor, the drowned mouth of the Charles River, is protected by islands at the harbor entrance (Fig. 236). The outer and the inner harbors together cover a large area, and have improved channels deep enough for the largest ocean liners. The total water front is 141 miles in length, but it is not all used. Boston ranks fourth among the great ports of the United States; in normal times over 40 steamship lines connect it with foreign countries, and there are many lines of steamers engaged in the coastwise trade. Enormous quantities of coal are brought by water to Boston both for use in the city and for distribution to the manufacturing cities tributary to it. Eastern Massachusetts is sprinkled with manufacturing cities, in which cotton and woolen mills and shoe factories are of first importance; hence Boston

FIG. 238. — Gloucester, Mass., one of the most famous fishing towns of New England. (*U. S. Bur. of Fisheries.*)

is a leading city in the importation of hides, skins, wool, and foreign-grown cotton.

The Coast of Southern New England has sunk less and is less indented than that of Maine, but this, too, is a region of hills and valleys and the sinking has converted the river mouths

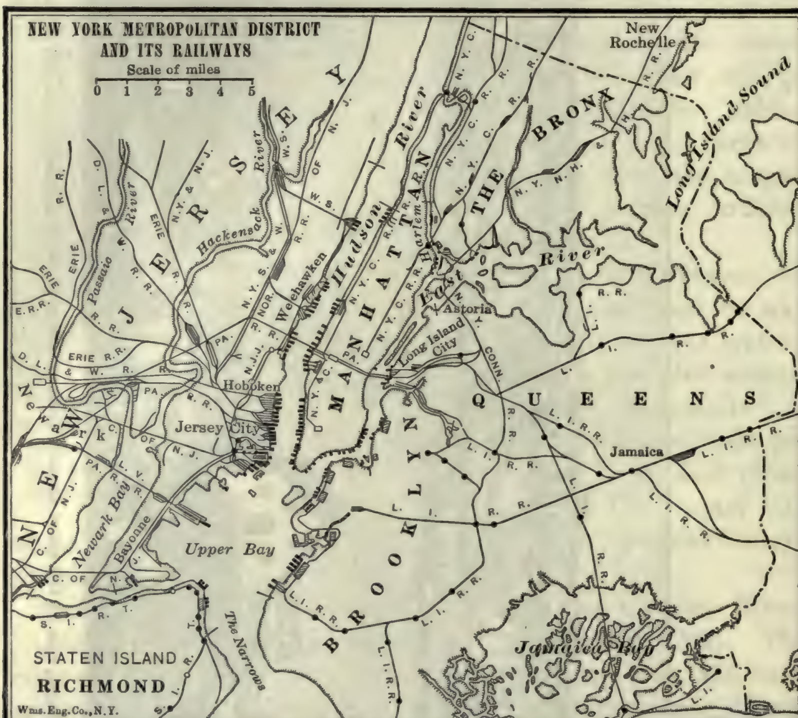


FIG. 239. — New York harbor and its environs.

into harbors. The coastal plain is nearly all submerged, but appears in places, as in Cape Cod Peninsula, Nantucket, Martha's Vineyard, and Long Island.

Narragansett Bay reaches entirely across one portion of Rhode Island, cutting the little state in two and giving Massachusetts a seaport, *Fall River*, on one of its arms. At the entrance to the Bay is *Newport*, a very fashionable and exclusive summer

resort and the seat of the United States Naval War College. On Providence River, at the head of the bay, is *Providence,* which is more largely devoted to manufacturing than to ocean commerce. Near one end of the recently completed Cape Cod Canal is the famous old whaling port of *New Bedford,* now a great cotton-manufacturing center.

Long Island, Manhattan Island, and Staten Island were formerly parts of the mainland, from which they have been separated by the sinking of the land. The same sinking of the coast gave Connecticut its much indented shore line and many harbors, large and small. On these harbors have sprung up a line of manufacturing cities including *New Haven, New London,* and *Bridgeport,* all of which get coal by water from ports in New Jersey, Pennsylvania, Maryland, and Virginia.

The New England Fisheries

Why Our Ocean Fisheries Are Important. — There are two reasons why the fisheries of the United States are important: (1) they supply us with a valuable kind of food; (2) the ocean fisheries are a school for seamen. Men in the fishing fleets often become expert sailors and many of them become the officers and seamen of our merchant vessels and ships of war. Up to the time of the Civil War the United States was one of the leading nations in the building of ships and in the ocean-carrying trade, and since the World War it has again become a great maritime power. The New England boat builders turned out sailing vessels of the swiftest type, and the New England fisheries developed a race of seamen as expert and fearless as any in the world. The American "Clipper" and the Yankee sailor were known in every port. New Bedford was once famous for its whaling fleet and *Gloucester* is still widely known for its fishing fleet which goes annually to the banks off Newfoundland and Nova Scotia (Fig. 226). Of the New England fishermen, the late Professor Ralph S. Tarr, who grew up among the fisher folk of Gloucester, wrote:

"Such contact with the sea develops bravery; nay, it demands bravery first of all and then develops it still further. The life of the fisherman who spends his days in an open boat on the heaving sea, which may at any moment be lashed by the fury of the storm wind, is such as to demand not merely braveness, but hardiness, quickness to see, and in an emergency, ability to judge and act with utmost coolness and fearlessness. The life of the fisherman is also calculated to develop a spirit of independence; he must also be patient and persistent. We will never know to what extent the development of these qualities among New Englanders and later transplanted in other parts of the country, is to be credited to the influence of the early life by the seashore; but for my own part, I believe this influence has been great. . . .

"The summer fishing for mackerel is pleasant, the boats cruising near the coast in the exciting search for schools of mackerel which, when sighted, are chased with large seine boats and then surrounded with the seine and taken aboard, either to be salted in barrels or to be quickly taken to the market and sold fresh. The winter fishing presents an abundance of excitement and danger. The fishing banks are notoriously stormy and foggy, and often the boats are so densely wrapped in the fog that objects only a few feet away cannot be seen. Then they are in danger of collision with icebergs and with ocean steamers, whose path lies directly across the fishing banks. It is by no means uncommon for a fishing schooner to go to the bottom with all hands, crushed like an eggshell beneath the bows of a huge transatlantic liner."[1]

New York Harbor.—New York has become the world's leading seaport (Fig. 239). The bay is the drowned mouth of the Hudson River, and is one of the best protected and most spacious among the great harbors of the world. The upper bay is almost entirely landlocked. It has mile after mile of water front on both sides of Manhattan Island, around the western end of Long Island, and along the New Jersey side — 748 miles in all. Projecting out from the land, like the teeth of a great comb, are some 800 piers and wharves, at which may lie the ocean liners, the huge freighters, and the vessels engaged in the coastwise trade (Fig. 239).

Along the New Jersey shore are the terminals of many railway systems which focus upon this port from the south, west, and north. Into these railway terminals roll the trains bringing the grain, meat, milk, fruit, cotton, lumber, coal, and every other commodity and every form of merchandise which the country is producing. The passenger, express, and mail trains which rumble in

[1] "The Fishing Industry of New England," *Bulletin of the American Bureau of Geography*, Vol. II, p. 44.

and out of these terminals are so numerous, especially at morning and evening, that they are like a procession.

Tens of thousands of people live in New Jersey but go to their business in New York daily. Until a few years ago all passengers for New York from the south and west, except those who came by the New York Central Railroad, had to get off the trains on the New Jersey side and be transferred across the Hudson River to New York on ferry boats. Now the Pennsylvania Railroad enters New York by tunnels under the Hudson River and discharges passengers at its mammoth station in the very heart of the city. Other tunnels also lead under the Hudson between Manhattan and New Jersey, and between Manhattan and Brooklyn on Long Island. Four bridges, each a mile or more in length, connect the Manhattan and Brooklyn portions of the city.

Scores of ferry boats pass to and fro day and night carrying people and vehicles from one point to another. There are so many ocean steamers, schooners, car ferries, passenger ferries, tugs, barges, lighters, pleasure boats, river craft, and harbor craft crossing, entering, and leaving the harbor that only an established system of signals prevents collisions. There are, for example, 10,000 lighters, or boats, which transfer freight cars from place to place along the water front.

The Equipment of a Great Port of Entry. — A great harbor requires many facilities for carrying on its operations. There are harbor lights that are watched and tended; a customhouse through which imported goods pass and pay duty; an immigrant station with officials, interpreters, inspectors, physicians, hospitals, quarantine station, and all the other facilities for registering, inspecting, and passing thousands of immigrants every month. There are police boats, fire boats, and revenue cutters; powerful dredges are always at work keeping channels open in places where the river deposits silt. There are fortifications with their huge guns and their quarters for soldiers and officers; drydocks where ships may be repaired, elevators for handling grain, and piers equipped with hoisting machinery for loading and unloading vessels. There are acres of train sheds, freight yards, and

stock yards, warehouses, cold storage plants, and offices of the commission merchants, and of other dealers and brokers. Yet all of these form only a part of the equipment of a great port.

The New Jersey Coast. — The coast of New Jersey between

FIG. 240. — The sandy beach at Atlantic City, N. J. (*Physiography Lab. Cornell Univ.*)

Raritan Bay (near New York Bay) and Philadelphia has little commerce because the shore is low and sandy without a deep harbor or a commercial city. But this very condition and the absence of commercial activity makes it an ideal coast for summer cottages, homes, and hotels, and for pleasure seekers from the great cities near by. Miles and miles of the coast are built up with summer homes, many of them palatial in character. In a few hours' automobile ride along the ocean boulevard you pass through a half dozen cities which include, in addition to the homes of the permanent residents, hotels, clubs, summer cottages, amusement places, and bazaars. The beach is white and sandy and as soft as velvet; the water is not deep and the huge waves, rolling in, make surf-bathing a delight (Fig. 240). *Atlantic City* is said to surpass any similar city in the world in the number and palatial character of its hotels. There are other stretches of coast, not yet given over to cottagers and summer visitors, where quaint

fishing towns, quite unlike the fashionable resorts, still remain.

Delaware Bay and the Port of Philadelphia. — South of New York Bay the first harbor of commercial importance is the estuary

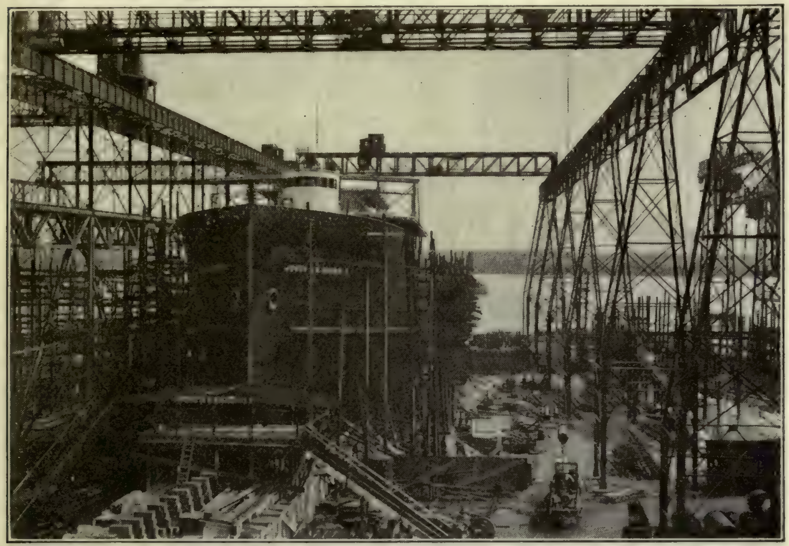


Fig. 241. — Steel steamship under construction in a Philadelphia shipyard. When ships were made of wood, Maine was our leading shipbuilding state. With the change to steel, the centers of this industry moved to the Delaware-Chesapeake region. (*Courtesy Cramp Shipbuilding Co.*)

of the Delaware River. At the head of ocean navigation on this river is Philadelphia, the third city in size in the United States, with 37 miles of water front. Philadelphia is one of the natural outlets for coal from the anthracite fields of eastern Pennsylvania, for the products of the great steel-making centers and for the oil fields of Pennsylvania and the interior. It is connected with foreign ports by over 30 lines of steamships, and with American ports by some 15 or 20 lines. It is one of the chief commercial, mercantile, and manufacturing cities of the nation. Opposite Philadelphia is *Camden* on the New Jersey side of the Delaware and

a little farther south is *Wilmington,* the chief city of Delaware. A canal built a century ago and soon to be enlarged, joins Delaware and Chesapeake bays. These bays are the nearest coastal waters to the principal iron- and steel-making centers, and have the

FIG. 242. — A portion of the oyster fleet of Baltimore in former years. Sailing boats are less in use at present. (*U. S. Bur. of Fisheries.*)

largest shipbuilding yards in the United States (Fig. 241). When wood gave place to iron and steel in the building of ships, the industry declined in New England and increased along the middle Atlantic coast because it is nearer the coal and iron regions. During

the World War the Delaware became the foremost shipbuilding river in the world, surpassing even the famous Clyde in Scotland.

Chesapeake Bay is the drowned mouth of the Susquehanna River, to which the Potomac and James were once tributaries (Fig. 243). This bay with its many branches is important commercially, and in addition contains the most productive oyster beds in the world. **Baltimore**, the most southerly of our four leading Atlantic ports, *Norfolk* and *Newport News*, at the mouth of the James, and *Washington* and *Richmond*, reached by river steamers, combine to make this an important stretch of coast. Several railways, reaching back into the coal fields, terminate here and make these ports especially important coal-shipping points.

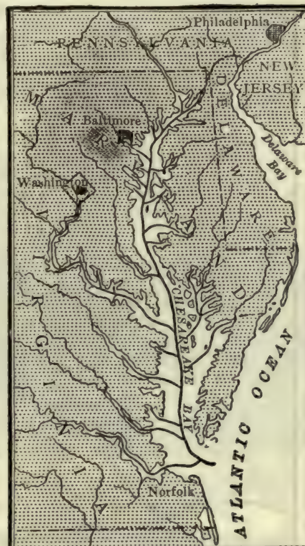


Fig. 243. — The branching Chesapeake. The lines show the probable position of the rivers that formed this branching, submerged valley.

The South Atlantic Coast. — South of Chesapeake Bay the coast becomes less indented. Much of the way it is skirted with long, slender islands of sand, built up by the waves and the wind (Fig. 244). Nearly all of the river mouths are slightly drowned and afford useful though not deep harbors as *Wilmington*, N. C., *Charleston*, S. C., *Savannah*, Ga., and *Jacksonville*, Fla. The export of cotton from some of these ports is very large, notably from Savannah. The opening of the Panama Canal has led to unusual activity along this coast, including deepening of harbors, building of railway terminals and wharves, and improvement of railway facilities between the coal fields and the sea board. The "Great Circle Route," the shortest water route between the Panama Canal and western Europe, lies near this coast, and

the South Atlantic ports should profit largely by the opening of the canal.

Sea-island Cotton. — The coast of South Carolina and Georgia is fringed with small islands; upon these and to a much greater extent on the mainland of Georgia and northern Florida grows the valuable *sea-island cotton*, a variety highly prized because of the long, fine, strong fiber which it yields.

Fig. 244. — Shore of North Carolina showing the long, narrow off-shore bars which are common along our south Atlantic and Gulf coasts.

The Florida Coast is the longest sea coast (1000 miles) possessed by any state, yet it has no deep harbors on the Atlantic side and only two or three on the Gulf coast. The peninsula itself is low and nearly flat, partly built up of coral and other kinds of limestone. Long, narrow sand bars lie parallel to almost the entire east coast. At the south, a line of coral reefs, called *keys*, form a chain of islands nearly 200 miles long (Fig. 246). One of the most notable railroad undertakings of recent years was the building of the Florida East Coast Railroad, whose southern section runs from island to island on concrete arches all the way to Key West, the most southerly city in the United States. This trip of 100 miles on the keys is described as "an ocean trip by railroad" (Fig. 247).

Sponge Fishing. — The sponges with which we are familiar are the skeletons of colonies of once living creatures. At the south-

ern end of Florida, sponge fishing is carried on both by divers and by fishermen using long-handled spears or hooks. This industry is rather more interesting than important, yet about 2000 per-

Fig. 245. — Lumber dock at Savannah, Ga. Southern yellow pine constitutes over one-third of the total lumber cut of the United States. (*U. S. Forest Service.*)

sons are engaged in it, and they market several hundred thousand pounds of sponges each year.

The Gulf Coast

From Florida to the Mexican border, the Gulf of Mexico is bordered by a low coastal plain with all the characteristics belonging to a rising coast. That, of course, means that there are few good harbors, and these require frequent dredging to keep them open. *Tampa* and *Pensacola,* Fla., and *Mobile,* Ala., are on large well-protected bays, and have a considerable commerce.

Florida is one of the large producers of lumber and of naval stores, which form the bulk of Pensacola's exports. Mobile is a cotton-shipping and lumber-shipping port and is becoming an

FIG. 246. — The Florida East Coast Railroad running about 100 miles on the keys to Key West.

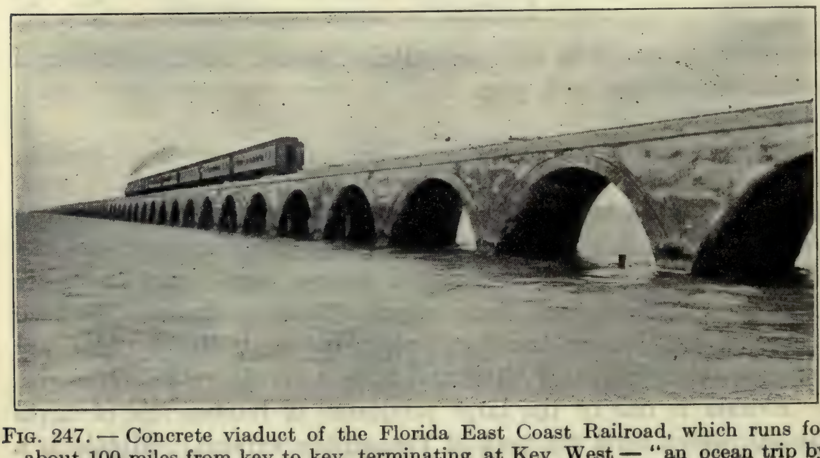


FIG. 247. — Concrete viaduct of the Florida East Coast Railroad, which runs for about 100 miles from key to key, terminating at Key West — "an ocean trip by railroad." (*Courtesy F. E. C. R. R.*)

outlet for the rapidly growing coal and steel district around *Birmingham,* Ala.

The Delta of the Mississippi. — A long time ago the Gulf of Mexico reached northward to the present mouth of the Ohio River, but this arm of the Gulf is now filled by the sediment poured into it by the rivers. The Mississippi is carrying its load of sediment out into the main gulf, each year depositing an amount twice as great as all the rock and earth removed from the Panama Canal. As shown in Fig. 248, the Mississippi discharges through several mouths called "passes"; these become partially filled with sediment that obstructs navigation. About 90 miles up the river is the city of *New Orleans,* and it is essential that the river be kept open for seagoing vessels at least for that distance. This has been achieved by building "jetties" or walls of earth and rock on each side of the river at certain of its mouths. These confine its course to a narrower channel, and compel it to flow with a stronger current so that it carries the sediment some distance out into the Gulf, thus preventing the clogging of the mouth. The delta is extending out into the Gulf at the rate of about 340 feet a year.

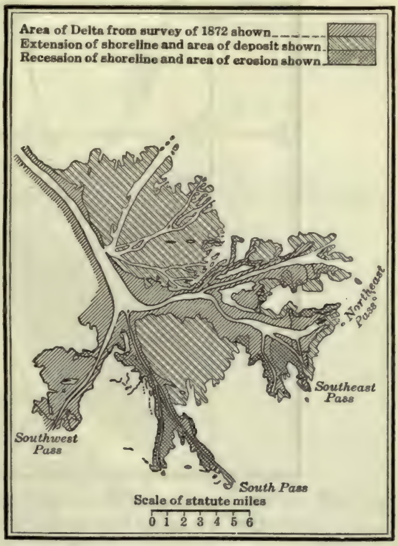


Fig. 248. — Map of the delta of the Mississippi River. Note the growth since 1872.

New Orleans and Galveston. — New Orleans and Galveston hold the place of leadership among the Gulf ports. In the value of their commerce New Orleans leads, and both rank next to New York. These two cities represent widely different types of harbors. New Orleans is a great river port 90 miles in from

the coast, placed there on a natural levee because the swampy delta of the river forbade the building of a city on the coast. Galveston, on the contrary, is built on a sandy island or bar some distance out from the coast (Fig. 249). Large sums of

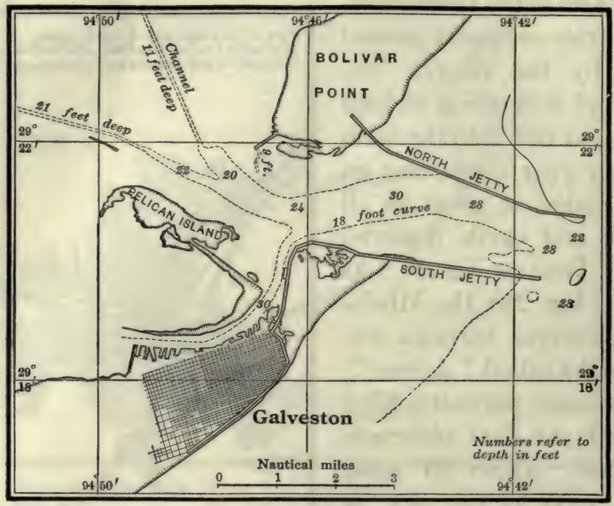


Fig. 249. — The location of Galveston on one of the bars near the Texas coast. Note that the piers and docks are on the sheltered side of the bar.

money have been expended in perfecting these two harbors. A ship canal 7 miles in length connects the city of *Houston* with Galveston Harbor.

The Pacific Coast

Characteristics. — This coast differs greatly from the Atlantic and Gulf coasts. Throughout almost its entire length mountains rise from near the water's edge. There is practically no coastal plain, and at only two places has the sinking of the land been sufficient to admit the sea through notches in the Coast Ranges so as to produce spacious harbors; these are *San Francisco Bay* and *Puget Sound.* The *Columbia River* has cut a channel to the sea through the mountains, thus permitting ocean vessels to ascend to the city of Portland.

At almost the extreme southern end of California is the harbor of *San Diego*, deep, landlocked, and ample for a large commerce. *Los Angeles*, growing with great rapidity, has reached 20 miles down to the sea and has consolidated with the ports

FIG. 250. — Oil derricks along the coast of Southern California. (*U. S. Geol. Sur.*)

of San Pedro and Wilmington. There is no inclosed natural harbor here, but an artificial breakwater gives protection to shipping.

The Harbor of San Francisco. — A long time ago the two rivers (the Sacramento and the San Joaquin) which now drain the Great Valley of California united and flowed through the Coast Ranges in a notch which the river itself had made. The sinking of the coast afterward drowned the mouth of this river so that the sea now enters, and behind the Coast Ranges broadens out into San Francisco Bay, 40 miles in length and deep enough for the largest ships afloat (Fig. 251). The entrance to the bay is the celebrated Golden Gate. The city of *San Francisco*

is on a peninsula between the bay and the ocean. Across the bay, chiefly at *Oakland,* are the terminals of several transcontinental railroads which reach this harbor. San Francisco has long been the chief port on our Pacific coast; the excellence of the harbor and its central position caused it to be made the terminus of the first transcontinental railroad. The gold deposits, the rich lands of the Great Valley, the lumber, and the ocean commerce have all combined to give this port large importance.

FIG. 251. — Map of San Francisco Bay and its cities. Most of the railroads do not enter the city directly, but terminate at points across the bay from San Francisco, and connect with the city by ferries.

Portland, 112 miles from the sea, is reached by ocean vessels by way of the Columbia and Willamette rivers. It is a beautiful city, the natural outlet of a large and productive region tributary to the Columbia River and its branches; this territory includes the great forests of western Oregon and Washington and the wheat lands of eastern Washington and Idaho.

The Puget Sound Ports. — From the state of Washington to Bering Strait stretches a coast wholly unlike that of Oregon, California, and Mexico. This northern coast has experienced much sinking and glacial erosion; there are endless bays and inlets and a continuous fringe of islands. The southernmost of these indentations is Puget Sound, the most spacious harbor on our Pacific coast. *Seattle* and *Tacoma* are the principal ports. Seattle is nearer the mouth of the sound than Tacoma; it handles the larger part of the ocean commerce, and

has had a marvelously rapid growth. Seattle is the western terminus of several of the great western railway systems, and is also an important steamship terminal for both Alaskan and Asiatic lines.

The Salmon Fisheries on the Pacific Coast. — The Pacific salmon are the most valuable fish of the western hemisphere, and with the single exception of the sea herring, are commercially the leading fish of the world. There are different species, the largest of which is the king salmon, averaging 25 pounds in weight, and sometimes reaching 100 pounds. The red salmon does not grow so large, but the rich color of the meat makes it a favorite for canning. The catching and canning of salmon has become a large industry on the Pacific coast from San Francisco to Bering Strait. The canning season extends throughout the summer and early fall and engages upwards of 35,000 people. From 400 to 500 million pounds of fish are caught annually. If the cans of salmon which are put up in an average year on our Pacific coast were placed end to end, they would encircle the earth at the equator.

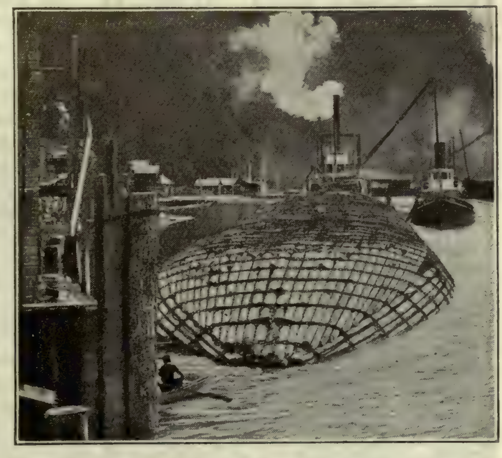


FIG. 252. — Log raft on the Oregon coast. Our north Pacific coast, with its heavy rainfall, has magnificent forests, but the coast south of San Francisco has very little timber. (*U. S. Geol. Sur.*)

Peculiarities of the Salmon. — After the young salmon hatch from eggs deposited far up a river by the mother, they go down the river and out to sea, where they live as salt water fish. When they reach maturity, in from two to four years, they seek the mouths of streams flowing into the ocean. So

eager are they to go far up the rivers that they will try time and again to leap up a waterfall or dam, and will often ascend falls of considerable height. After they begin their journey upstream they eat no food, and shortly after depositing their eggs they die. The eggs hatch slowly, depending upon the temperature of the water; in some cases the process requires seven or eight months. When a school of salmon is proceeding up a river it is like an army; in one stream in Alaska the United States Bureau of Fisheries arranged a device which enabled men to count the fish as they passed through narrow gates. On one day 324,000 were counted and on another 402,000. Over 2,500,000 were counted during that run, which lasted through July and part of August.

FIG. 253. — Map of Puget Sound.

Nets and seines are stretched across parts of the rivers and fish-wheels are constructed in shallow channels to catch the fish as they swim up the stream. The government regulates the salmon fisheries and thus seeks to prevent the catching of so many as to diminish permanently the supply for future years.

The Alaskan Seal Fisheries. — The value and importance of the fur seal may be judged from the fact that a sealskin coat costs hundreds of dollars. The most important herd of seals in the world lives in the north Pacific and each season collects on the Pribilof Islands near Alaska (Fig. 255); formerly there were 4 or 5 million seals in this herd, but the seal hunters reduced it almost to the point of extermination. The peculiar habits of the seal make the animal an easy prey; the Alaskan seals always go to the same small islands during the breeding season. Strangely enough, they have selected for their breeding place islands

which are from 100 to 200 miles away from the waters where they obtain their food. This compels the mother seals to swim all this distance to get food; they make the trips every five or ten days, and return faithfully to care for their young. The

FIG. 254. — A log boom at one of the great saw mills of the Northwest — at Tacoma. (*U. S. Forest Service.*)

seal hunters, knowing this habit, found it easy to kill them when they were swimming back and forth. Killing the seals has been forbidden for a period of 15 years by a treaty entered into by Great Britain, Russia, Japan, and the United States, and it is believed that the herd will again grow to large size.

Suggestion. — The author has prepared no summary of this chapter. It is suggested that the pupils prepare summaries as follows:

1. The Atlantic coast of the United States. (About 200 words.)
2. The Gulf coast of the United States. (About 100 words.)
3. The Pacific coast of the United States. (About 200 words.)

FIG. 255. — Thousands of seals on the Pribilof Islands, off the coast of Alaska.

EXERCISE XXII

1. Why is the coast line of the United States especially well suited to the needs of a commercial nation?
2. Why has New England no coastal plain?
3. Why is the coast of Maine so irregular?
4. Why has shipbuilding declined in importance on the New England coast?
5. Why, with its many fine harbors, has Maine no very large cities?
6. Why does a coast like that of Maine develop a "sea-faring instinct" in men?
7. Why does New England use a great amount of coal?
8. Why are there many manufacturing cities along the New England coast, but not along the New Jersey coast?
9. Why is New York harbor an excellent one?
10. Why is the coast of New Jersey especially well suited for pleasure resorts?
11. Why do the Delaware and Susquehanna rivers have large bays at their mouths?
12. Why are many shipyards located in the region of Delaware and Chesapeake bays?
13. Why is coal a particularly large item in the shipments from middle Atlantic ports?
14. Why are there relatively few deep harbors along the south Atlantic and Gulf coasts?
15. Why is the commerce of the south Atlantic ports smaller than that of the north Atlantic ports?
16. Why is sea-island cotton so called? Why is it more valuable than ordinary cotton?
17. Why does the Mississippi discharge through several mouths? Why are jetties needed at some of these mouths?
18. Why was the city of New Orleans not located at the mouth of the Mississippi?
19. Why has the Pacific coast of the United States few indentations?
20. Why is there a gap through the mountains at the Golden Gate?
21. Why is the harbor of San Francisco an exceptionally good one?
22. Why is the Puget Sound country likely to become a great commercial region?
23. Why is the coast from Puget Sound to Alaska very irregular?
24. Why are there fewer cities on our Pacific coast than on our Atlantic coast?
25. Why is the character of the coast line a matter of large importance to a country or a region?

CHAPTER XVIII

THE FORESTS AND FOREST INDUSTRIES OF THE UNITED STATES

The Habits of Forest Trees.—Wherever soil and climate will allow them to grow, trees are nature's favored crop. Hundreds of kinds of forest trees grow in the United States; there are, for example, about 60 species of maple, 70 species of pine, and 300 species of oak. Not only do the leaf, wood, and shape of every species of tree differ from those of every other, but every kind of tree has its own peculiarities and habits. During past ages the different species of trees have acquired habits and abilities which enable them to live, some under one set of conditions and some under another. The kind of situation in which a tree or other plant ordinarily grows is called its *habitat*. It seems to be nature's determination that something shall live in every possible place, and since the earth furnishes an endless variety of places, or habitats, an endless variety of plants may exist.

Adaptation of Trees to Climate and Soil. — Among the forest trees, some have learned to live in a cold climate and some in a warm; some require wet soil, and others dry; some can grow in the shade, and others must always have light and space. For example, the mangrove of Florida grows in the swamps, while the rock oak grows on dry, barren ridges; the mesquite is content to live in the desert and the jack pine in sand barrens, but the black walnut will grow only in the richest of soil. Hemlock will grow in the shade of the white pine, but the white pine will not thrive in the shade of the hemlock or of any other tree; the rubber tree cannot live where frosts occur, but the birch will grow in the frigid zone. The variety known as the canoe birch will live year after year in the intense cold of the arctic and grow

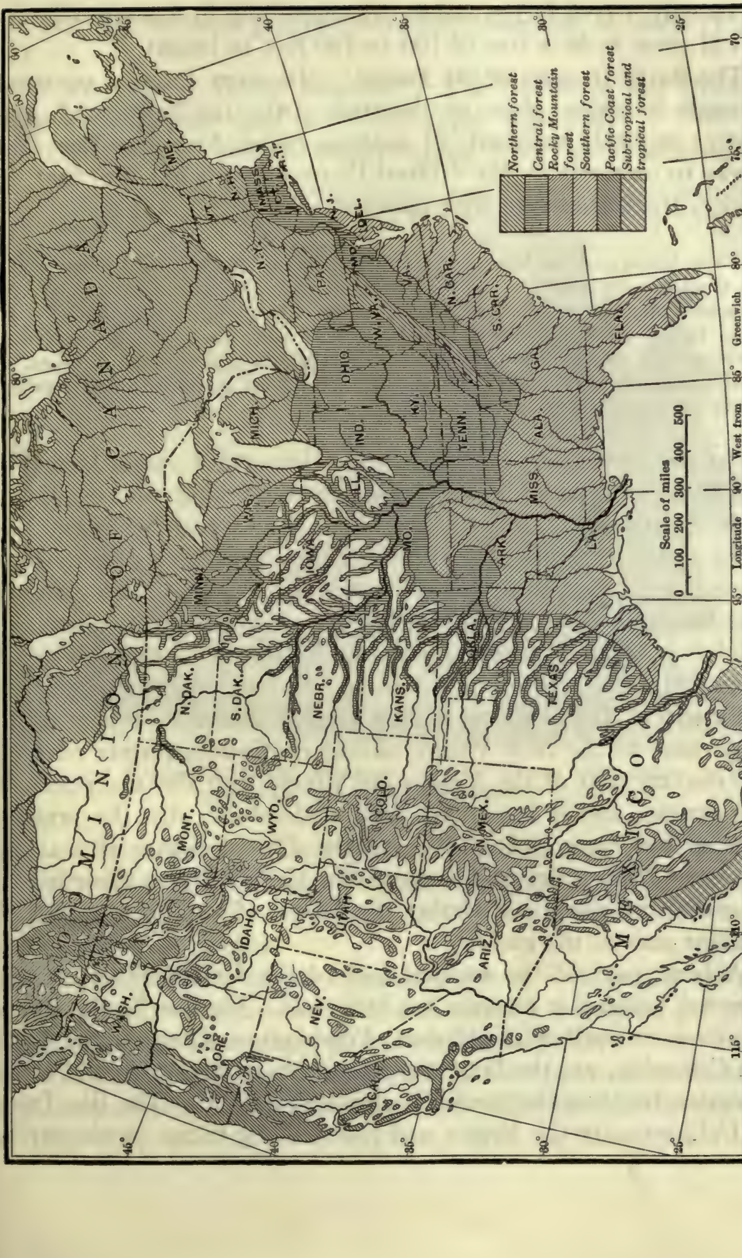


FIG. 256. — Map of the original forest areas of the United States. (Data from U. S. Forest Service.)

to be only 4 or 5 inches tall in 50 years, but in a warm climate it will grow to be a tree of 100 to 120 feet in height.

The Battle Ground of the Forest. — In every forest a constant struggle is taking place as the trees strive for light, food, and water; probably hundreds of saplings perish for every one that grows to maturity. Mr. Gifford Pinchot points out also that, in a way, trees coöperate with another:

> "The history of the life of a forest is a story of the help and harm which the trees receive from one another. On one side every tree is engaged in a relentless struggle against its neighbors for light, water, and food, — the three things trees need most. On the other side, each tree is constantly working with all its neighbors, even those which stand at some distance, to bring about the best condition of the soil and air for the growth and fighting power of every other tree."

On the whole, rainfall is the most important single factor in deciding where forests shall grow and what kind they shall be. This is strikingly shown as you cross the Cascade or Sierra Nevada mountains near our Pacific coast. On the eastern slope there are few forest trees and those that do grow look stunted and hungry. But as you cross to the western slopes, where the rainfall is heavy, dense and magnificent forests cover the ground (Fig. 209).

Extent of the Forests of the United States. — When white men came to the New World, almost continuous forests covered the country east of the Mississippi River, with the exception of the prairies, and it is not yet fully understood why the prairies had so few trees. According to the United States Bureau of Forestry, " the original forests of the United States exceeded in quantity and variety of timber the forests of any other region of similiar size on the globe."

A large part of the western half of the United States is not forested because it receives too little rain. On the Pacific slope, however, in northern California, Washington, Oregon, and British Columbia, are the largest trees and finest forests in all North America, for there the rainfall is ample (Fig. 209). The Big Trees of California are the largest and oldest living things on the earth.

You may see in those groves trees 1500 years old or more (Fig. 257).

Our Five Great Forest Regions. — The forests of the United States have been grouped under five types (Fig. 256):

1. *The Northern forests,* which extend from Minnesota eastward to the Atlantic. They contain hemlock and many kinds of hardwoods, but the most valued tree was the white pine, now nearly gone. Up to about 1905 these forests were our leading source of lumber.

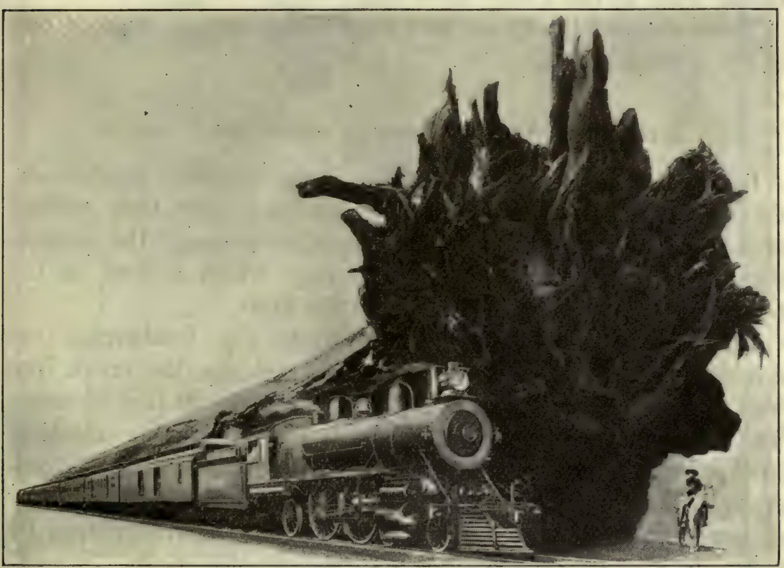


Fig. 257. — A California "Fallen Monarch" with a railway train drawn to the same scale. (© *Southern Pacific Co.*)

2. *The Central or Interior Hardwood forests.* — A great deal of the timber in this region was cut and burned merely to get rid of it, so that the land might be used for agriculture.

3. *The Southern forests,* in which the yellow pine is dominant, are now supplying more lumber than any other part of the country (Fig. 259).

4. *The Rocky Mountain forests* are scattered and varied, but almost wholly coniferous (cone-bearing), with pines predominating.

5. *In the Pacific forests,* the stately Douglas fir and the cedar predominate (Fig. 209). Washington has been the foremost lumbering state in the Union since 1905.

There are practically no hardwood forests in the western half of the United States.

Industries Which Depend upon the Forests

Lumbering. — The United States is the foremost lumber-producing nation, and the value of its lumber exceeds 1500 millions of dollars yearly. There are two main divisions of the lumbering and wood-working industries, logging, which is done in the forest, and sawing, which is done in the mills.

(*a*) *Logging.* In the northern forests the lumbermen cut down the trees, trim off the branches, and saw the trunk into logs of convenient lengths, ranging from 10 to 20 feet or more. The following paragraphs, though describing logging methods in Wisconsin, apply equally well to the northern pine forests generally. These methods of lumbering are, however, largely out of use; most of the logs that are now cut are transported by railroads.

"To-day the white pine forests are scarcely more than a memory; but for forty years lumbering was the dominant interest in the northern half of Wisconsin. Into the pineries every winter went small armies of men. Down its rivers every spring the river-men drove thousands upon thousands of pine logs. Along these rivers hundreds of sawmills stood, and around the mills grew up the lumbering towns, many of them the cities of to-day.

"Naturally the trees near the rivers were cut first, for the principal method of transporting the logs to the mills was by floating them down the rivers. At first only the best parts of the choice trees were taken. Each season the logging camps pushed farther up the streams and farther back from the banks, as the timber was cut away. The logs were hauled by horses or by logging railroads to the rivers, and by thousands were piled on the ice and along the banks, awaiting the spring 'break-up,' when the melting snow turned the river into a torrent (Fig. 261). When the break-up came and the mass of logs moved, the most exciting and dangerous employment of the lumberman

FIG. 258. — Map showing the number of lumber mills and the relative production of hard wood and soft wood lumber in each state. (*After map by U. S. Forest Service.*)

began. To guide and control this plunging, driving, rolling avalanche of timber, and to prevent or to break a jam called for the coolest heads, and the most alert, most daring men on the river."

Logging methods differ widely in different parts of the country. For example, in the rugged topography and dense forests of Washington and Oregon, where the trees are of exceptional

FIG. 259. — Logging methods in the South — quite unlike those of our northern states and eastern Canada.

size, stationary engines drag the logs by cables to logging railways, by which they are taken to the mills. In the cypress swamps of the South logways are opened through the swamps and the logs are moved by floating.

(*b*) *The sawmills* saw the logs into rough lumber of many dimensions; some of the lumber is used in this rough form and some is further manufactured into flooring, siding, doors, sash, boxes, furniture, wooden ware, and hundreds of other forms for special uses.

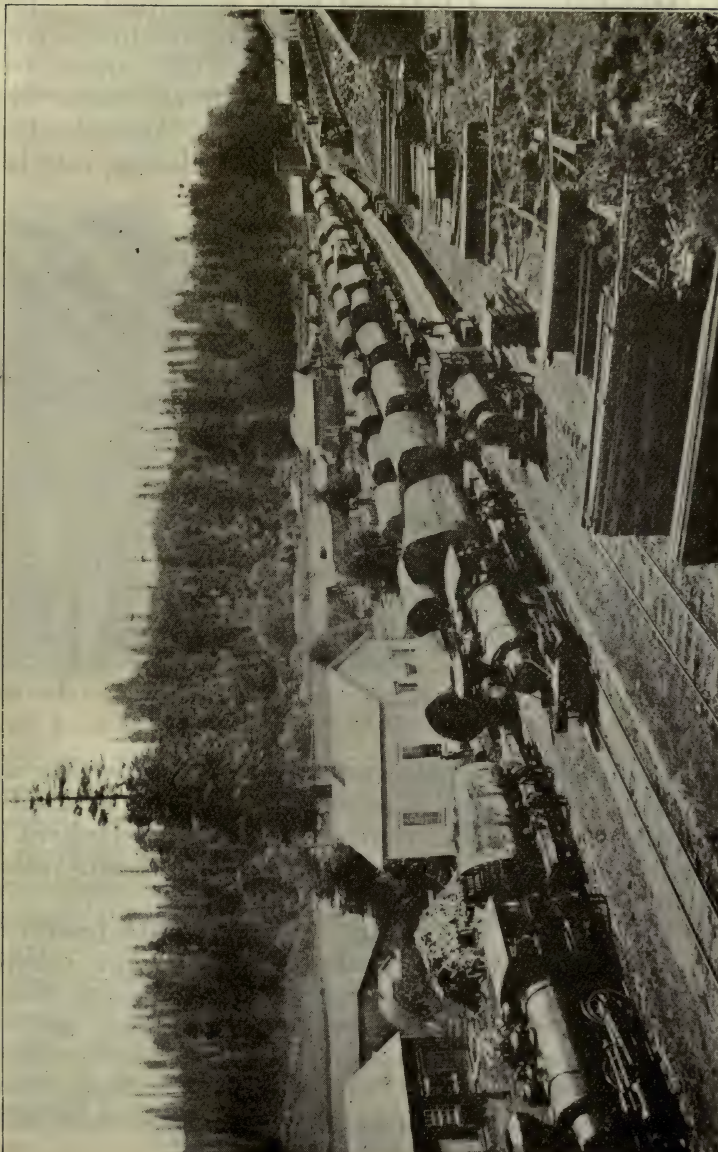


FIG. 260. — A California redwood tree sometimes made a trainload of logs. (*U. S. Geol. Sur.*)

The Manufacturing of Pulp and Paper from Wood. — Most grades of paper in America are now manufactured from a pulp made of wood fiber. Spruce is preferred for this purpose, but hemlock, poplar, and several other woods are also used. The states that lead in this industry are New York, Wisconsin (Fig. 262), Maine, New Hampshire, and Pennsylvania, not only because these states have pulp-wood, but also because they are near Canada from which it is imported. Moreover, all of these states have abundant water power, the chief power employed in the paper mills; they are also in the section of the country where the great printing and publishing centers are located.

Fig. 261. — In regions of heavy snow and spring floods, the streams are often employed to transport the logs to the mills.

The Use of Wood in Tanning. — Tanning is the process of making hides and skins into leather, a process which consists mainly in soaking the hides in tanks or vats of tanning fluids. These tanning extracts were formerly obtained from hemlock and oak bark; so the earlier tanneries were built near the northern forests in Pennsylvania, Wisconsin, and New York. Now bark is used much less; instead, chemicals and extracts made

from chestnut wood and from a South American wood, called quebracho, are being used more and more. The small tanneries, once so common, have disappeared and large ones, controlled by great corporations and located in or near large cities, have replaced them.

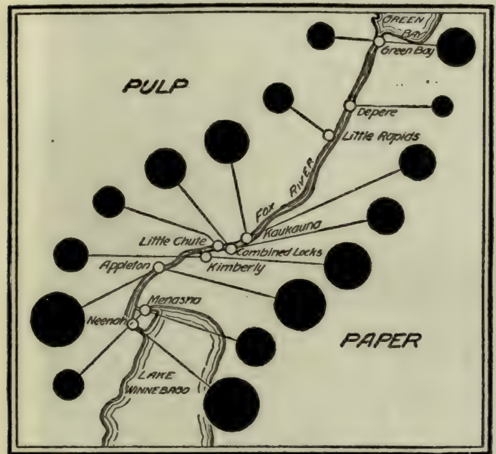


FIG. 262. — Location of the pulp and paper mills along the lower Fox River in Wisconsin. The scale may be taken from the small circle for Depere, which represents a daily production of 32,000 pounds of paper. Nearly all of the mills use water power. (*Wis. Geol. Sur.*)

Other Forest Products. — From the pine trees of the South \$25,000,000 worth of turpentine and resin (together called *naval stores*) are annually made. The crude turpentine is obtained by cutting gashes in the trunks of the growing trees and collecting the thick liquid that flows from the gashes (Fig. 263). *Wood alcohol* and various chemicals are made from waste wood by a process of distilling. *Maple sugar* is made from the sap of the maple tree, particularly in Vermont and New York. But the chief item, next to lumber, among forest products, is *fire wood* or stove wood, which is cut from wood-lots on the farms and is mainly used by the farmers themselves or by inhabitants of near-by villages. The United States Forest Service estimates the value of this wood at the huge sum of \$250,000,000 a year.

The Importance of Retaining Forests on Steep Slopes. — Besides the timber which they supply, forests perform valuable services while they are standing. On slopes they prevent the erosion of the soil. During heavy rains or the melting of snows the dense tangle of roots in the soil acts like a sponge and holds

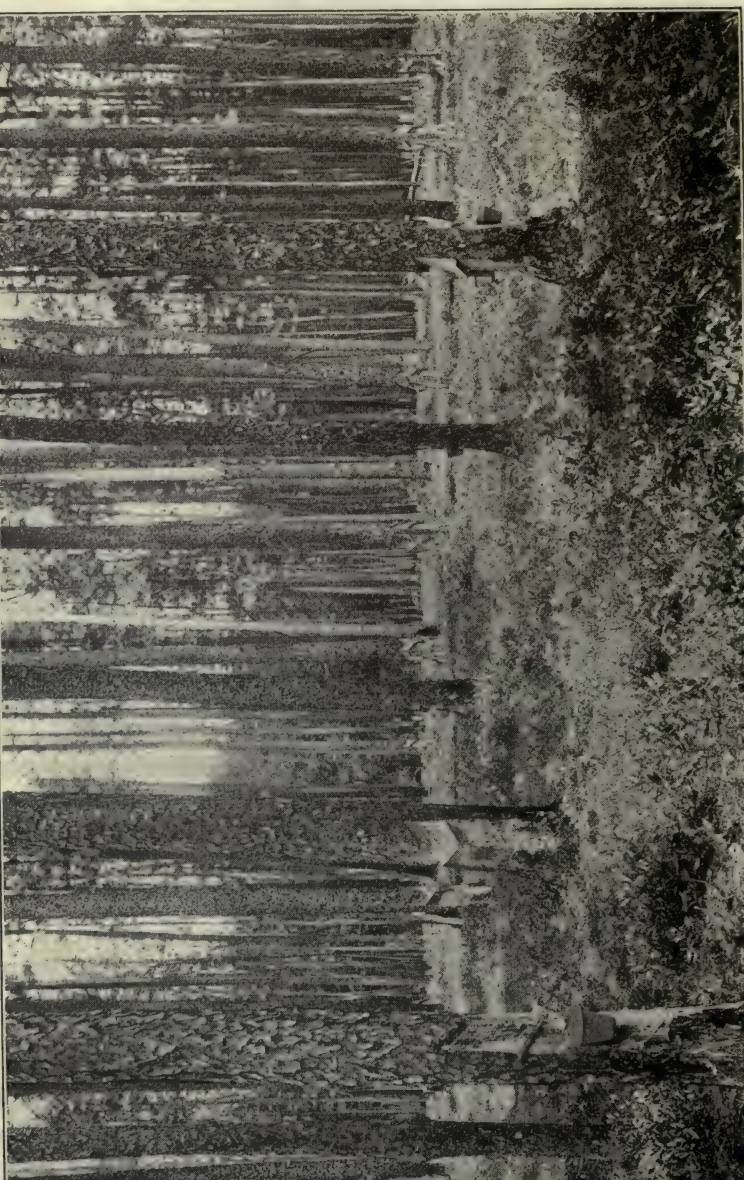


FIG. 263. — Forest of long leaf pine from which naval stores are produced. (*U. S. Geol. Sur.*)

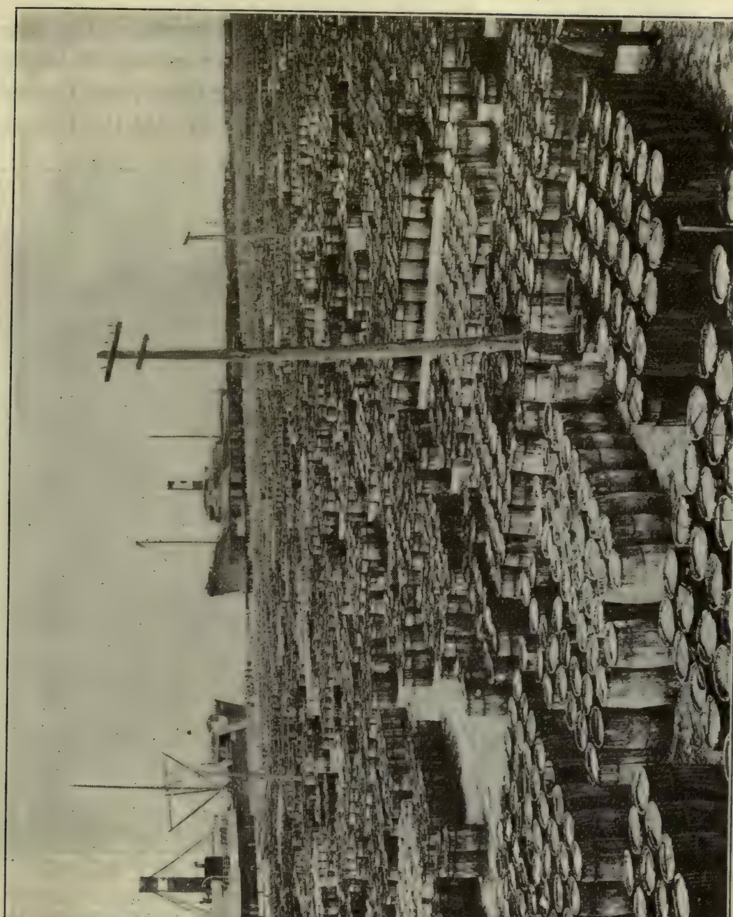


FIG. 264. — Thousands of barrels of resin on the wharf at Savannah, Georgia. This city is the chief naval stores market of the world. (*U. S. Geol. Sur.*)

the water, in this way checking the run-off and aiding in the prevention of floods. In the mountains there are extensive tracts of land which are too steep and rocky to produce crops, and forests are the natural and proper growth on such lands. If the forests

FIG. 265. — Ruinous soil-erosion following deforestation. (*U. S. Geol. Sur.*)

are removed, the soil is quickly eroded, and soon the slopes become barren and useless (Fig. 265). The interests of the nation require that the forests on these non-agricultural lands shall not be ruthlessly stripped off, but that only such trees as are at their best for lumber or other purposes shall be cut from year to year. Our government, through its policy of forest reserves and through the encouragement of scientific forestry is trying to check the avoidable waste of such forests as it still controls. Most of our forests,

however, have already passed into the possession of private individuals or corporations and the methods of lumbering followed in them cannot be controlled by the government.

The Waste of Timber and the Loss by Forest Fires. — In the logging operations of the past, nearly one-fourth of all the

Fig. 266. — Logged-over lands in northern Wisconsin. The rubbish left on the ground easily catches fire and starts the disastrous forest fires which cause enormous losses. (*U. S. Geol. Sur.*)

timber logged was lost or wasted in the forest (Fig. 266). Of the three-fourths that reached the mills, fully a third was wasted or turned to small account. The remainder went into building operations or to factories for further manufacturing, where still more was lost. Experts estimate that we have been wasting five-eighths of the tree and using three-eighths. Some of this loss was, of course, unavoidable. The present high price of lumber, however, is leading to greater care, and wastes are being cut down. The older methods used in the turpentine or naval stores industry destroy in a few years great numbers of fine trees, each of which has taken 50 or 100 years to grow.

Forest Fires. — But the most appalling loss of all is by the dreaded forest fires. The United States has lost from this one cause nearly as much timber as it has used. This is a shocking statement and seems hardly possible, but it is supported by the best of authority. These losses still continue, but the conservation movement has drawn the attention of the public to the avoidable waste and a better state of affairs is slowly coming. The United States Forest Service believes that "by reasonable thrift we can produce a constant timber supply beyond our present need and with it conserve the usefulness of our streams for irrigation, water supply, navigation, and power," and that "under right management our forests will yield over four times as much as now."

EXERCISE XXIII

1. Originally about one-half of the area of the present United States was forest covered. Where was the largest unforested portion? Why there? (See Fig. 256.)

2. One-half of these forests has already been cut. Give two reasons why they have been so rapidly removed.

3. There are five great forest belts:

(*a*) *The Northern Belt*, extending from Maine to Minnesota and reaching south along the Appalachians. White pine was the most valuable timber of this belt; more than 70 per cent of this has been cut. Suggest reasons why such a high percentage of this timber has already been removed.

(*b*) *The Southern Belt*, on the coastal plain from New Jersey to Texas. Yellow pine predominates; over 50 per cent of this has been removed. At present this belt is our largest source of lumber. It is also our chief source of naval stores. What are naval stores? How obtained? For what used? The Gulf states lead in the production of these stores.

(*c*) *The Central Hardwood Belt.* Eighty per cent of the timber has already been removed; this is the highest proportion in any belt. Can you give reasons? What are some of the most useful hardwoods? For what used?

(*d*) *The Rocky Mountain Belt.* This timber is in scattered patches and is largely a variety known as western pine; 75 per cent of the timber of this belt still remains. Why is so much more left in this belt than in the first three mentioned?

(*e*) *The Pacific Belt* is most heavily wooded near the coast where the rainfall is heaviest; it is nearly all soft wood. Douglas fir predominates; 75 per cent of the timber is still left. The leading lumber-producing state is Washington.

4. Every year we take an average of 250 cubic feet of wood per capita from our forests; France takes only 25 cubic feet. Why do we use so much more?

5. Eight kinds of wood make up over 80 per cent of our forest products; yellow pine leads, followed by Douglas fir, oak, white pine, and hemlock. Which of the five forest belts produces each of these?

6. Lumbering is distributed widely over the country; 18 states produce a billion board-feet or more a year each. A board-foot is 12 inches square and one inch thick.

7. The annual value of our forest products at the place of production is from $1\frac{1}{2}$ to 2 billion dollars, but the lumber finally costs the consumer several times as much. This amount is about 12 per cent of the value of our farm products. Make a list of the principal uses to which wood is put. Three-fourths of the timber cut is soft wood. Can you explain why?

8. Our largest uncut forests are in the Gulf states and the Pacific states. Explain why.

9. Forty years ago three-fourths of our timber lands were owned by the nation or by the states. Now four-fifths are owned by individuals or corporations. Less than a dozen companies now hold a quarter of all the privately owned timber in the United States, and 200 holders own one-half of our timber lands. How have private companies gained such enormous holdings of timber? Discuss the wisdom of our government in permitting this. What are the gains and the losses to the public? Remember that some of our great western railroads would not have been built until long after they were, had our government not aided them by these land-grants.

10. From 1875 to 1900 the Great Lakes region (especially Michigan and Wisconsin) was the chief producer of lumber. Why was the lumber of this region cut before that in the South and in the Far West?

11. The chief products of our forest industries are (*a*) lumber in many forms for building purposes; (*b*) fire wood; (*c*) wood pulp and paper; (*d*) furniture; (*e*) tanning extracts; (*f*) naval stores. Mention some of the sections of the country where each of these industries is carried on.

12. The waste of wood is enormous. Point out some of the chief causes for this waste and loss.

13. Name 8 to 10 kinds of wood which are particularly well suited to specific uses, *e.g.*, for paper-pulp, cross-ties, furniture, shingles, flooring, packing boxes, etc.

14. Paper and pulp are mostly made in the northern forest belt. Give three reasons. In what states are the leading paper-making centers?

CHAPTER XIX

GEOGRAPHICAL ASPECTS OF TRANSPORTATION

The Dependence of Modern Life upon Transportation. — In a pioneer community the people supply nearly all their own wants, producing most of the food that they eat, the lumber or other materials for their homes, the fuel that they use, and even the material for their clothing. Hundreds of such communities still exist in the mountains of Kentucky and Tennessee. Miss Ellen Semple, writing in 1901, has thus described one of them:

"In one of the most progressive and productive countries of the world, and in that section of the country which has had its civilization and its wealth longest, we find a large area where the people are still living the frontier life of the backwoods, where the civilization is that of the eighteenth century, where the people speak the English of Shakespeare's time, where the large majority of the inhabitants have never seen a steamboat or a railroad, where money is as scarce as in colonial days, and all trade is barter. It is the great upheaved mass of the southern Appalachians which, with the conserving power of the mountains, has caused these conditions to survive, carrying a bit of the eighteenth century intact over into this strongly contrasted twentieth century. . . .

"The furnishings of the cabins are reduced to the merest necessaries of life, though in the vicinity of the railroads or along the main streams where the valley roads make transportation a simpler problem, a few luxuries like an occasional piece of shop-made furniture and lamp-chimneys have crept in. One cabin which we visited near the foot of Pine Mountain, though of the better sort, may be taken as typical. Almost everything it contained was homemade, and only one iron-bound bucket showed the use of hardware. Both rooms contained two double beds. These were made of plain white wood, and were roped across from side to side through auger-holes to support the mattresses. The lower one of these was stuffed with corn-shucks, the upper one with feathers from the geese raised by the housewife. The sheets, blankets, and counterpanes had all been woven by her, as also the linsey-woolsey from which her own and her children's clothes were made. Gourds, hung on the walls, served as receptacles for salt, soda, and other kitchen supplies. The meal-barrel was a section of a log, hollowed out with great nicety till the wood was not more than an inch thick. The flour-barrel was a large firkin, the parts held in place by hoops, fastened by

an arrowhead at one end of the withe slipped into a slit in the other; the churn was made in the same way, and in neither was there nail or screw. The wash tub was a trough hollowed out of a log. A large basket was woven of hickory slips by the mountaineer himself, and two smaller ones made of the cane of the broom corn and bound at the edges with colored calico were the handiwork of his wife. Only the iron stove with its few utensils, and some table knives, testified to any connection with the outside world. The old flint-lock gun and powder-horn hanging from a rafter gave the finishing touch of local color to this typical pioneer home. Daniel Boone's first cabin in the Kentucky wilderness could not have been more primitive."[1]

In an American city, or for that matter in almost any home that has the benefits of modern transportation, things are quite different. For a small sum one may have a dinner brought together from every continent: grapefruit from Florida; olives from Spain; fish from the banks of Newfoundland; bread from wheat grown in Manitoba, ground in Minneapolis, shipped in a sack made of Texas cotton in a factory in Massachusetts; beef from a steer grown in Kansas, fattened in Iowa, and slaughtered in Chicago, seasoned with salt from Michigan and pepper from Sumatra; salad made of bananas from Costa Rica, grapes from Spain, walnuts from California, seasoned with a dressing made of mustard from Madagascar and olive oil from Italy; coffee from Brazil with sugar from Cuba, drunk from a cup made in Trenton, N. J., stirred with a spoon made in Meriden, Conn., from silver mined in Mexico. The napkin may have been woven in Connecticut, from linen made of flax from Russia. The chair may have been made in Grand Rapids, Mich., from oak grown in Georgia, seated with leather tanned in Boston from a goat skin imported from Asia. The rug on the floor may have been made in Philadelphia from Australian wool, colored with German dyes. There is scarcely a well-laid table or a well-furnished room in an ordinary home that does not represent a list much like the above. Cheap, rapid transportation enables the average American family to enjoy comforts and luxuries that even princes did not know in the Middle Ages.

[1] "The Anglo Saxons of the Kentucky Mountains," in *The Bulletin of the American Geographical Society*, Vol. XLII, pp. 561–594.

The Use of Rivers in a New Country. — It has already been pointed out (Chap. VIII) that in a new country, where forests are dense, the rivers are almost the only routes for explorers, traders, and settlers. Throughout the million square miles of territory in Canada in which the Hudson Bay Fur Company operates, the hunters, trappers, and all others use the rivers and lakes as routes of travel. In the vast stretches of Siberia, in the Amazon basin, and in Central Africa, the waterways are still almost the only highways. In China, Germany, France, and, to some extent, Russia, rivers have been joined by canals forming a network of routes for boats. While the cost of carrying merchandise on rivers may be low, this was not always true. The early steamboats from New Orleans to Louisville charged an average of 5 cents a pound for freight and $125 for a passenger. Half rates were charged for downstream traffic. These prices are many times higher than the present railroad rates.

The Canals of the United States. — The United States had its Canal Period, but it was so quickly followed by the Railroad Era that canal transportation in this country was really important for only a little more than one generation. The most important of these canals were constructed between 1825 and 1840 (Fig. 267). Nearly a dozen canals in New York connected the larger lakes and rivers with one another or with the Erie Canal. Three canals, each about 50 miles long, were built in New England, but were among the first to be abandoned. Two crossed New Jersey from New York Bay to the Delaware River; one of them (the Delaware and Raritan) is still in use. A large number of canal projects were carried out in Pennsylvania, and Maryland and Virginia attempted without success to complete water connection between the Atlantic and the Ohio River. Ohio built several canals, the principal ones being the two that joined Lake Erie with the Ohio River. Indiana constructed a canal joining the Ohio River with an Ohio canal leading to Lake Erie. Illinois connected Lake Michigan with the Illinois River, which flows into the Mississippi, and in Wisconsin a half-successful attempt was made to build and maintain a waterway

between Lake Michigan and the Mississippi River. Most of these canals were useful for a time and aided largely in the development of the regions which they traversed; but the majority

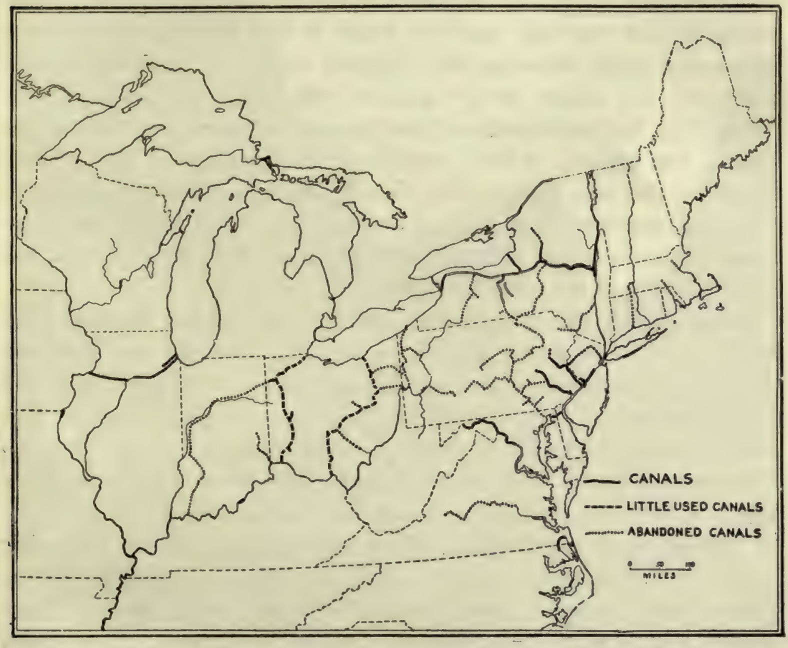


FIG. 267. — None of the canals are used very extensively, and the two canals in Ohio are practically abandoned.

of them did not pay, were allowed to fall into disrepair, and have been abandoned or nearly so (Fig. 267).

The Erie Canal. — The most successful of all these canals was the Erie in New York, uniting Buffalo on Lake Erie with the Hudson River at Troy and thence with New York City, a total distance of 425 miles. The story of this famous waterway reads like a romance. Nature had prepared the route; the sinking of the land had converted the Hudson into a deep, navigable river with a spacious harbor at its mouth. The Mohawk, a branch of the Hudson, had cut a notch through the east-

ern mountains and thus had prepared a route to the Ontario plain of western New York, a plain so level that it contains stretches of the canal 50 miles long without a lock. New York was fortunate in possessing the only low gap in our eastern mountains, in fact the only possible route in the United States for a successful canal between the Atlantic and the interior of the country. No other factor was so influential in making New York City the metropolis of the nation as those features of the state's topography which permitted the joining of the Great Lakes to the sea, thus giving New York, for a half century, the principal east-west highway of the nation. The Erie Canal has twice been enlarged and has recently been rebuilt and enlarged at an expense of over $150,000,000.

Lake and River Transportation in the United States. — It would be well to review at this point the story of the rise and decline of navigation on the Mississippi River (page 140), and the accounts of the remarkable increase in navigation on the Great Lakes (page 147). It is a noteworthy fact that prior to 1914 we had more ships on these lakes than there were American ships on the ocean engaged in our foreign commerce.

Valleys and Railways. — The topography of the country to be traversed is one of the most important matters in selecting railway routes. Engineers search out and survey these routes with great care, because the railroad must, if possible, avoid heavy grades and sharp curves. In a rough country, valleys whose streams have graded their channels to easy slopes are almost invariably selected for railways. The route having been selected, the construction of a railroad is largely a process of grading; that is, cutting and filling. When the Pennsylvania Railroad was building, the chief engineer estimated that on the level stretches the road could be built for $10,000 a mile, on the western slope of the Alleghenies for $28,000 a mile, and on the very steep eastern slope for $50,000 a mile. A 40-mile section of the road over the Alleghenies cost nearly twice as much as a 60-mile section along a river valley. Nor does the extra cost end when the road is built, for every heavy train that passes

Fig. 268. — Cañon of the Grand River in Colorado. Among lofty mountains, such cañons provide almost the only possible railway routes through the mountain barriers. (*Courtesy D. & R. G. R. R.*)

FIG. 269. — Railroad to Cripple Creek, Colo. An example of the difficulties of railroad-building among mountains.

FIG. 270. — Valley of the New River in the Allegheny Plateau, West Virginia. In a region of such topography, the river valleys form about the only feasible routes for railways. (*U. S. Geol. Sur.*)

over this mountain division requires one or more extra locomotives, thereby adding to the cost of transportation. About every important river valley in the Appalachians has been taken possession of by some railway.

Mountain Passes and Railways. — Low passes are of utmost importance to railway builders, and the early railways which

Fig. 271. — View on the Denver & Rio Grande Railroad along Eagle River, Colorado, illustrating the importance of stream valleys and cañons as railroad routes through mountains.

got possession of such natural routes as the Mohawk Valley in New York, the Susquehanna-Juniata Valley in Pennsylvania, and the Potomac Valley between Maryland and Virginia, have become the great trunk lines of the East. In the western mountains the railroads that got possession of the low passes secured an advantage worth millions of dollars. A bitter struggle occurred between two rival railroad companies, both of which were

determined to get control of the Royal Gorge of the Arkansas River through the Front Range of the Rocky Mountains (page 139). The passes in the Alps have been important influences in determining the routes of several of the main railroads of central Europe, and the same general principle holds true of railroad-building in any mountainous region.

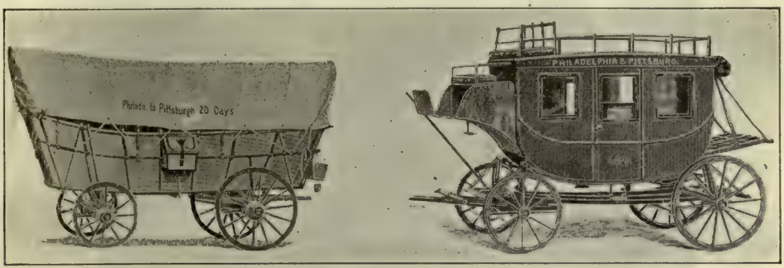


FIG. 272. — The Conestoga wagon and the stagecoach by means of which freight and passengers were carried between Philadelphia and Pittsburgh before the day of railroads.

Growth of Transport Facilities in the United States. — This part of our country's history is as fascinating as a story; it is dealt with more fully in Chapter VIII. The story begins with the Indian canoe and the French bateau; on the rivers it is a story of flatboats laboriously propelled by poles, of clumsy arks, of great lumber rafts, of keel boats that could ascend the streams as well as float down them, of the first crude steamboats, puffing and splashing along, of ever improving river steamers, until we reach the period of the "Floating Palaces" carrying their gay parties between New Orleans and St. Louis before the Civil War. On land the story takes us through the days when long trains of pack horses in single file carried people and goods along narrow trails from Philadelphia to Pittsburgh in 20 days. It is said that in the years around 1780, as many as 500 pack horses a day sometimes passed through Carlisle, Penn. One proprietor at Harpers Ferry had 200 pack horses and nearly a hundred men employed in carrying goods and passengers. The "packers" vigor-

ously opposed the building of roads and fought hard to prevent the introduction of wheeled vehicles.

Roads. — Soon after 1800 an agitation for good roads began. The great Cumberland National Road, designed to reach from

FIG. 273. — One of the excellent roads over the Swiss Alps. (*Physiography Lab. Cornell Univ.*)

Cumberland, Md., to the Mississippi River at St. Louis, was begun in 1811 but was completed only to Vandalia, Ill. Over these turnpikes long trains of canvas-covered wagons (Fig. 272) rumbled and creaked, their owners charging a hundred dollars a ton or higher for conveying goods between Philadelphia and Pittsburgh. In those days salt sold for $5 a bushel, and iron for 20 cents a pound in Pittsburgh. There was a still earlier period when the "flying stagecoaches" covered the distance from Boston to New York in 5 days and made the 90 miles from New York to Philadelphia in 3 days. Even as late as 1824, Thurlow Weed wrote that it took him 6 days and 7 nights to go by stagecoaches from Albany to Rochester, N. Y., a distance of 225 miles.

The First Railroads. — The next improvement in roads consisted in laying wooden timbers to which strips of band iron later were nailed. At first, horses were used to draw the cars; early in

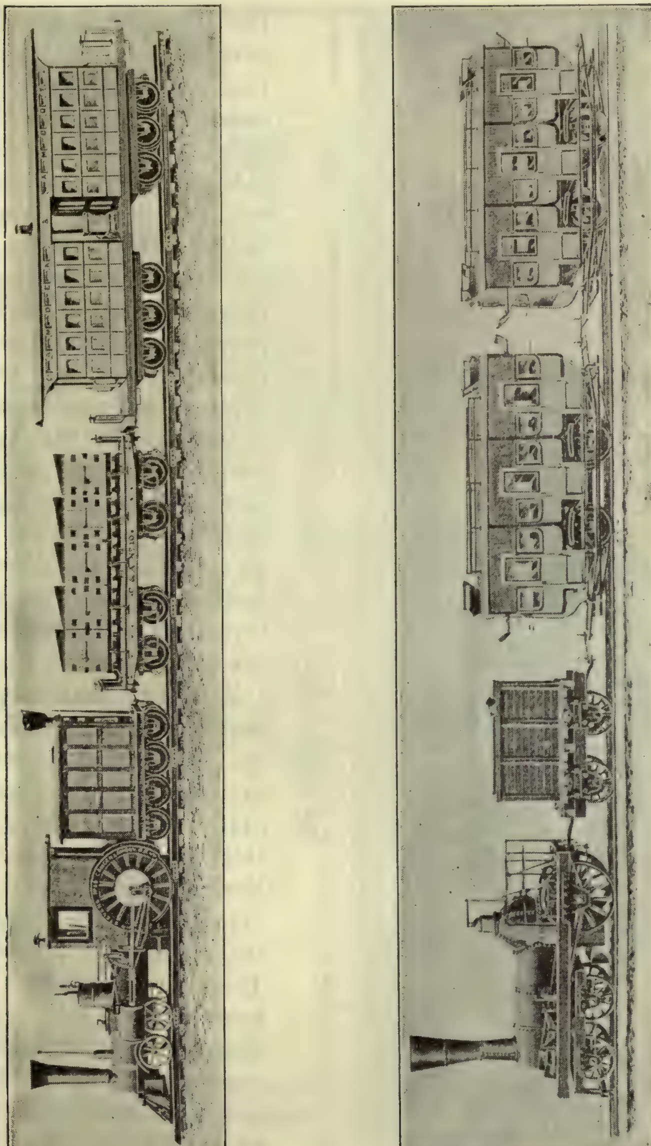


Fig. 274. — Upper view; the locomotive "Lancaster" and train, Phila. and Columbia R. R., 1834. Lower view; the "John Stevens" and train, Camden and Amboy R. R., 1849. Contrast with locomotive in Fig. 275.

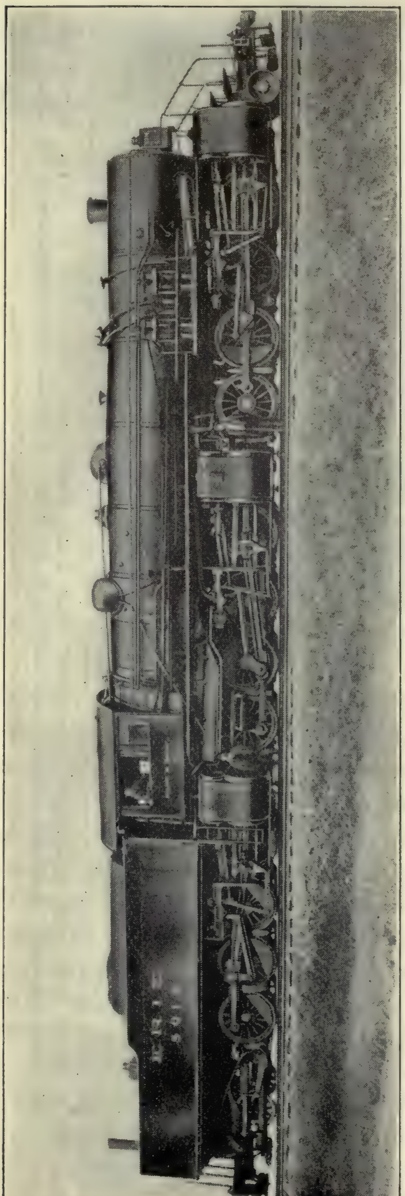


Fig. 275. — Centipede locomotive, 105 feet long; 24 drive wheels; weight, 90,000,000 pounds; capable of handling 640 loaded freight cars. *(Courtesy Erie R. R. Co.)*

1829, three crude locomotives were brought from England. The early locomotives are described as being "so covered with rods and joints that they resemble a huge grasshopper" (Fig. 274). It is a strange fact that every important step in the improvement of transportation methods has been opposed by people who either feared that their own profits would be endangered, or who glorified "the good old days." By these people railroads and steamships were ridiculed and their utter failure was predicted.

Extent of Railroads in the United States.—There are over 260,000 miles of railroads in the United States, more than the total railroad mileage of Europe and Asia combined, and 40 per cent of the mileage of the world. There are a number of reasons for this: the United States has a large population and a large area, yet China and Russia are even larger. But the

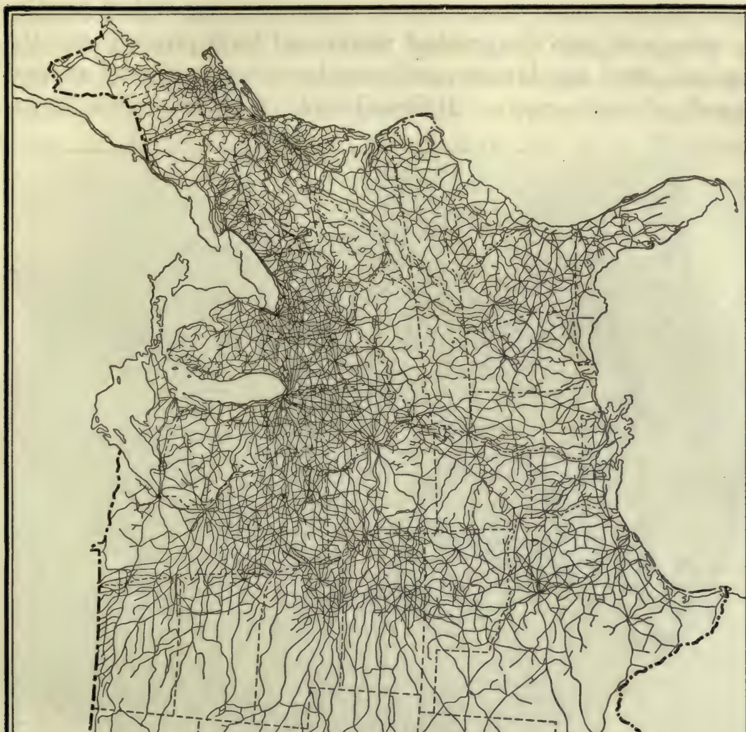


Fig. 276. — Railroad map of the United States.

people of the United States travel more than any other people; they raise and ship the greatest amount of farm produce, use the most coal, steel, and lumber, and manufacture the greatest amount of goods of any country. Railroads are, of course, most numerous in wealthy and progressive countries; in the United States they are most numerous in the level farming section of the Middle West, where they form a perfect network (Fig. 276).

Fig. 277. — Railroad system formerly known as the "Harriman Roads"; the Southern Pacific, the Union Pacific, and subsidiaries.

Railroad Systems of the United States. — More than two-

thirds of the railroad mileage of this country is comprised in ten great systems which have been built up or bought up by men united in corporations which control vast wealth. The so-called Vanderbilt System includes nearly as many miles of railway as there are in all Canada. At the time of Mr. E. H. Harriman's

FIG. 278. — Railroads making up the "Hill Lines"; the Great Northern, the Northern Pacific, the Burlington, the Colorado and Southern, and subsidiaries.

death (1909), the Harriman System (Union Pacific, Southern Pacific, and others) included a railway mileage greater than that of Italy and Spain combined (Fig. 277). The so-called "Hill Roads" (Northern Pacific, Great Northern, Burlington, and others) equal in length those of Brazil (Fig. 278), and the roads domi-

nated by the banking house of J. P. Morgan & Co. nearly equal in mileage all those of Argentina. So powerful did these railroad corporations become that the government found it necessary to curb them and to establish a degree of control over them.

The Vanderbilt System, built up around the New York Central Lines, serves the section of country extending from Boston and New York through New York State to Chicago, Cincinnati, and St. Louis.

The Pennsylvania System, whose lines cover more than 10,000 miles, serves the region just south of this from New York and Philadelphia through Pennsylvania, Ohio, Indiana, and Illinois to Chicago and St. Louis (Fig. 280). Several lesser systems also traverse this area and the region immediately south of it. The Southern Railway System is the most extensive in the South. Several others serve the Mississippi Valley in a generally north and south direction, the leading ones being the Louisville and Nashville, and the Illinois Central. No less than seven lines connect the Mississippi Valley with the Pacific coast; the Great Northern, Northern Pacific, and the Chicago, Milwaukee, and St. Paul serve the northern section and terminate on Puget Sound. The Union Pacific and the recently completed Western Pacific serve the central belt and terminate at San Francisco Bay. Farther south are the Santa Fe and the Southern Pacific lines which reach San Francisco Bay after entering California at the south.

During the World War, the United States Government took over the railroads and operated them as if they formed a single great system.

Cost of Transporting Goods by Different Methods. — By comparing the cost of transporting goods by different methods, the advantages of railroads and steamships are brought out. In parts of China coolies carry goods long distances, or wheel them in wheelbarrows scores or even hundreds of miles. Camels are used in the desert, while the sure-footed llamas are the principal pack animals of the Andes Mountains. Dogs are used in Alaska, Greenland, and other parts of the frigid North; the reindeer in Lapland, the yak in Tibet, and the burro in many lands.

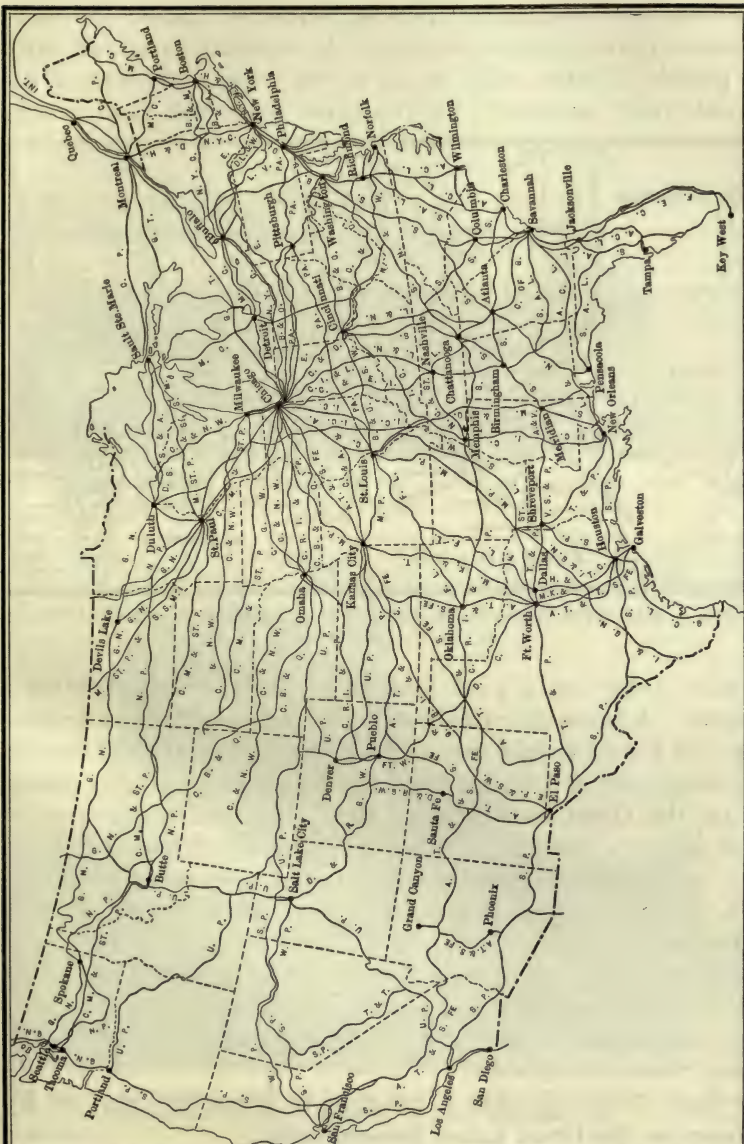


FIG. 279. — Main-line railroads of the United States.

In Siberia and Manchuria grain is frequently hauled 100 miles by horses drawing clumsy wagons. An ordinary camel can carry 300 pounds 25 miles a day at an average cost of 50 cents a ton per mile (per ton-mile). A two-horse team can haul 2 tons

FIG. 280. — Map of the Pennsylvania Railroad System, one of the principal systems of the United States.

20 miles a day on a good road at a cost of about 20 cents a ton-mile. A locomotive can draw, at the rate of 400 miles or more a day, 40 loaded freight cars each carrying from 10 to 50 tons, at an average cost of 1 cent a ton-mile; and the ore-carrying steamers on the Great Lakes have carried iron ore at the rate of $\frac{1}{20}$ of a cent a ton-mile. Stated briefly and *for averages:*

It costs about 50 cents a ton-mile to transport goods by camels.

It costs about 40 cents a ton-mile to transport goods in China by porters.

It costs about 20 cents a ton-mile to transport goods in the United States by horses and wagons.

It costs about 1 cent a ton-mile to transport goods in the United States by railways.

It costs about $\frac{1}{20}$ cent a ton-mile to transport iron ore by steamers on the Great Lakes (pre-war rate).

FIG. 281. — Unloading a Great Lakes coal carrier at Green Bay, Wis. Coal is the second largest commodity carried on the Lakes. (*Wis. Geol. Sur.*)

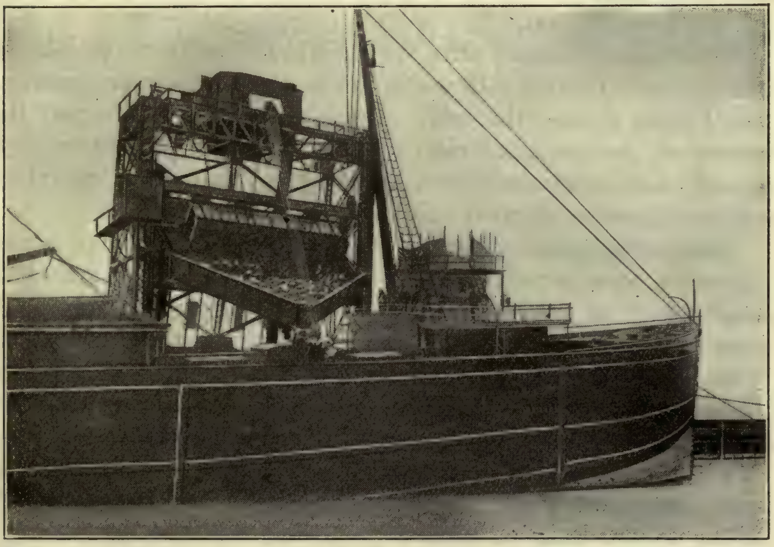


FIG. 282. — Dumping a carload of coal into the hold of a lake steamer. Most of the coal shipped on the lakes is loaded by this rapid method. (*U. S. Bur. of Mines.*)

Summary

By the cheap, rapid, and well-organized transportation systems of land and sea, we are now provided with the products of almost every place and clime. The items connected with an average dinner may be drawn from possibly forty or fifty localities scattered widely over the earth.

Methods of transportation differ according to the stage of a country's progress. Rivers are of great importance in the exploration and early development of a country and they may continue to be of much use.

In the United States, in Europe, and in China, canals were once much used, and in Europe they are still important, but in this country their period of greatest usefulness passed when railroads became common. New York, Pennsylvania, and Ohio expended a great deal of money on canals. The Erie Canal in New York was a splendid success and has recently been enlarged at the cost of over $150,000,000.

River valleys usually offer the easiest railroad routes in hilly or mountainous regions. Hence in the eastern and western parts of the United States, the main stream courses have directed the routes of the principal railroads. Low passes and water gaps usually determine the points at which railroads cross mountain ranges and so are of great value to railway builders.

Transportation on water has progressed from the Indian canoe, through various types of river boats (bateaux, flatboats, arks, keel boats, etc.) to the steamboat. In this country the only large development of inland water transportation is on the Great Lakes.

On land, methods of transportation have progressed from the time when men carried loads on their backs along forest trails, or pack animals carried them along narrow, crooked paths, to the day of turnpikes with freight wagons and stagecoaches, on to the time when wooden rails were laid and horses hauled the cars, down to the present Railroad Era.

The United States has 40 per cent of the railroad mileage of the world; two-thirds of this is comprised in ten great railroad sys-

tems. The majority of these systems, either directly or through connecting lines which they control, have one of their terminals in Chicago, the greatest railroad center in the world.

Water transportation on the ocean or on our Great Lakes under the most favorable conditions is very cheap, being as low as one-twentieth of a cent a ton-mile for coal and iron ore, while the average railway freight rate is many times as much, and the average cost of hauling by horses more than a hundred times as much.

EXERCISE XXIV

The author has provided no review or test questions on this chapter. It is suggested that the pupils themselves prepare this set of questions, perhaps 25 in all; some of them ought to be "Why" questions, others "Where"; some should be such that the answers are found directly in the chapter, while others should call for thought, reasoning, comparison, and possibly for information related to the statements in the text, yet not found there.

CHAPTER XX

MANUFACTURING AND MANUFACTURING CENTERS IN THE UNITED STATES

Growth of Manufacturing in the United States. — Modern factories, with acres of buildings and thousands of employees, came into existence within the memory of people who are now living. Of such great size are some of these plants that they and the workmen's homes would form cities of considerable size. The slow, tiresome hand labor and the crude appliances (Fig. 283) which produced the wares of colonial days have given place in this country to mills and factories which together turn out upwards of a million dollars' worth of manufactures every five minutes of the working day (Fig. 284).

Rank of the United States. — This country has become the greatest of manufacturing nations. It produced in the years just before the World War twice the value of manufactured goods produced by Great Britain and three times the value of those produced by Germany.

Four Essentials of Modern Manufacturing. —

1. *Power,* — mainly derived from coal.
2. *Capital,* — money or other property employed in business.
3. *Labor,* — both skilled and unskilled.
4. *Ability* on the part of selected men to build up and conduct great enterprises.

Every one of these has a vital part in manufacturing. The study of geography, however, does not to any large extent treat of capital, labor, or business ability.

Importance of Coal. — It was pointed out on page 34 that the power concealed in coal is the stored-up sunshine of past ages, that in 300 pounds of coal is stored away the capacity for doing

as much work as an average workingman can perform in a year. When the steam engine was discovered and man found a way to use this energy locked up in coal, one of the greatest steps in the progress of mankind was taken. Step by step the steam engine

FIG. 283. — An old mill in eastern Pennsylvania. In similar mills much of the manufacturing of a half century ago was done.

has been improved, becoming ever larger and more powerful. Inventors are constantly devising new machines that will do quickly and perfectly the work which before only skilled mechanics could do and do slowly; and behind most of the machines are the coal-burning engines that furnish the power. This is one of the reasons why the nations which have abundance of coal lead the world.

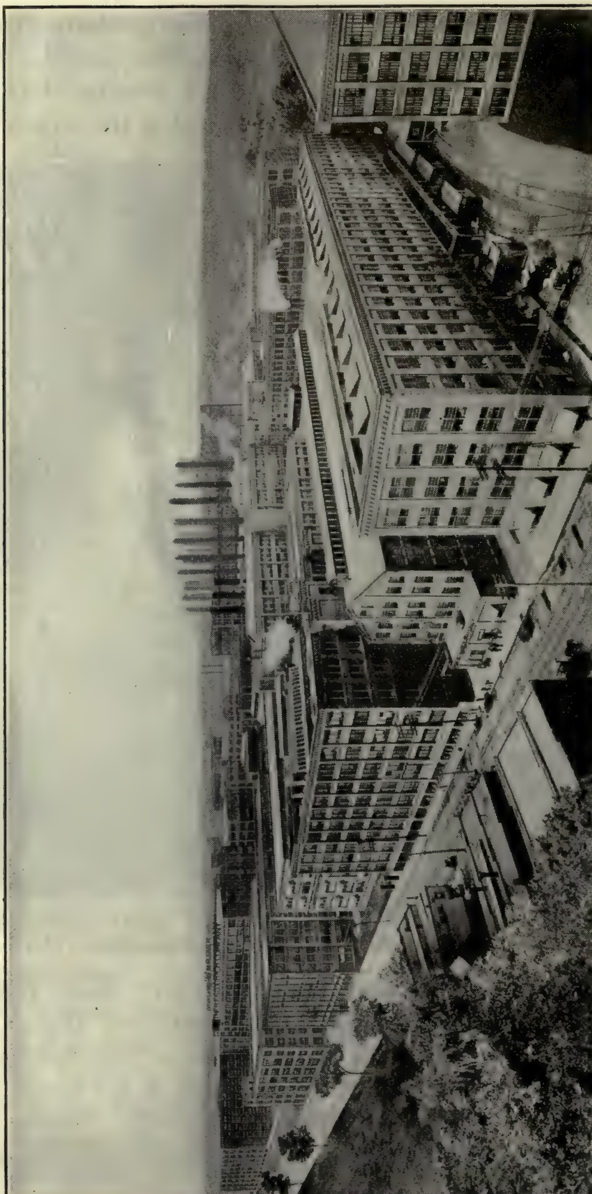


Fig. 284. — Plant of the B. F. Goodrich Rubber Company, Akron, Ohio. Akron is the foremost rubber-manufacturing city in the world. *(Courtesy of B. F. Goodrich Co.)*

Factors That Affect the Growth of Manufacturing. — In most lines of manufacturing many different companies are engaged, each striving for a share of the business. This severe competition makes push, resourcefulness, and economy necessary, and the manufacturer must study constantly how he can cut down the cost of production and increase his sales. The success of his business depends upon many factors, with some of which the study of geography is concerned:

Cost of Fuel. — The power which drives three-quarters of our machinery is steam power derived from coal. Single establishments may use tens of thousands of tons annually; its weight makes it relatively costly to transport, hence factories which use much coal aim to locate where they can get it cheaply. The cost of transporting commodities does not always depend upon distance; railways may charge as much for hauling coal 20 miles as 200 miles, but as a rule, distance counts. The cost of transporting heavy and bulky commodities by water is usually less than that by rail, and factories which can secure coal or raw materials by water may have an advantage. This is shown in the rapid growth of iron and steel manufacturing near the Great Lakes.

Available Water Power. — Water power is used much less than steam power in manufacturing; yet, as a rule, it is cheaper, and wherever it is available factories are likely to spring up, as in New England, and at points such as Paterson, Rochester, Niagara Falls, and Minneapolis.

Cost of Transporting Raw Materials. — Into the price of every pair of shoes, for example, enters the cost of transporting the hides from which the leather is tanned, and into the price of every piece of furniture enters the cost of transporting the lumber.

Factories commonly effect a saving by being near the source of the principal raw materials which they use. In actual practice there are many exceptions to this; for example, more cotton goods are made in Massachusetts than in any cotton-growing state. This is because Massachusetts possesses other advantages which more than offset the disadvantage of being a long way from the cotton fields.

Nearness to Markets. — This does not always mean nearness in miles. A place 500 miles away, but connected by railroad may for business purposes be nearer a given place than another only 20 miles away which is not connected by railroad. Nearness must

FIG. 285. — Distribution of cities in the United States. The size of the dot is proportional to the size of the city. (*U. S. Dept. of Agr.*)

be counted in terms of cost of transportation. Articles are sometimes shipped across the Atlantic for less than the cost of a railroad haul of a few hundred miles or a wagon haul of 20 miles. Although this is true, factories situated in the eastern states, where a dense population furnishes a great market, have advantages over similar factories located in sparsely settled sections of the country.

Ten Reasons for the Great Development of Manufacturing in the United States

1. *An Invigorating Climate.* — In every phase of a nation's life the climate is of fundamental importance. For mental and

physical vigor a cool climate with variable weather is best, and in most parts of the United States, as in most parts of Europe, the climate favors an energetic life and the cultivation of the work-habit.

2. *An Energetic People.* — Americans are descended from Europeans, the most advanced people of the world; and amid the great opportunities of a new and rich country they have developed a degree of push, inventiveness, and power of organization which is unsurpassed in any other people.

3. *Great Natural Resources.* — The United States is a large country, and it possesses resources of almost every kind, including coal, iron, copper, gold, lead, zinc, petroleum, and other minerals, an enormous area of agricultural land, and great forests.

4. *Abundance of Fuel for Power.* — The coal resources of the United States are the greatest possessed by any nation, and include about one-half of all the known coal in the earth.

5. *Capital for Carrying on Enterprises.* — The natural wealth of the United States has yielded the people of this country a vast amount of capital and this has enabled them to build up their manufacturing and other industries, which, in turn, create more capital.

6. *A Great Home Market.* — A hundred million people, earning and accumulating money with a rapidity elsewhere unknown, make the greatest market for manufactured goods afforded by any country. Ordinarily 90 per cent of our manufactures are used within the country.

7. *Improved Machinery and Abundant Labor.* — The latter has been constantly increased by immigration from Europe.

8. *Facilities for Transportation and Communication.* — For example, there are more miles of railway in the United States than in Europe and Asia combined, and twice as many telephones as in all the rest of the world.

9. *Government Encouragement.* — This is largely accomplished by a protective tariff, which has helped to keep out foreign manufactures and has allowed our own a favorable opportunity for growth. It is doubtful if this protective tariff is longer needed, except in a limited number of new industries.

10. *A Home Food Supply.* — This is not strictly essential to the growth of manufactures, as the case of England shows, but it is a decided advantage.

Summary

Briefly summarized, the reasons for America's leadership in manufacturing are:

1. The invigorating climate
2. The inventive and mechanical genius of the people
3. The stored-up energy in its coal deposits
4. The wealth of raw materials
5. The capital which has been accumulated
6. The improved machinery and the abundance of labor
7. The great home demand for manufactures
8. The superior railway facilities and means of rapid communication
9. The protective tariff during the earlier years of growth
10. The ability to provide at home a great food supply

Why Manufacturing Is Centered in the Northeastern States. — Manufacturing is done in all of the states, but 75 per cent of it is done in states which lie north of the Ohio and Potomac rivers and east of the Mississippi River. A narrow strip of land only 100 miles wide, extending from Massachusetts to Baltimore, is the leading *factory belt* of the United States (Fig. 286). Of our thirty greatest manufacturing cities, twelve are in this small strip. Fifty per cent of our total manufacturing is done in five states — New York, Pennsylvania, Illinois, Massachusetts, and Ohio. The question arises — *Why do five states manufacture as much as the other forty-three?*

1. The eastern states were settled earliest. New England had in general, (*a*) thin and bowlder-strewn soil which discouraged agriculture, (*b*) rapid rivers affording water power, (*c*) many harbors, and (*d*) people who possessed an aptness for manufacturing and business.

2. The richest coal beds and those first to be developed are in the northeastern states, though New England, New York, and New Jersey have no coal beds within their own borders.

FIG. 286. — Of the 48 leading manufacturing cities, 21 are in the extreme East, and most of the others are in the north central states.

3. Ohio, Indiana, Michigan, and Illinois all have coal; these states were settled mainly by people from the East, many of whom had had some experience in manufacturing.

4. The eastern states get the largest supply of labor, because nearly all the immigrants land at the Atlantic ports.

5. The early start, the abundant labor and capital, and the rapid growth of business in the East led to the early building of railroads, which still further increased the manufacturing advantages of these states.

The mills of New England are, to a noteworthy extent, engaged in the making of articles which have high value in proportion to their bulk, for all the coal and most of the raw materials must be brought in, and then a large part of the manufactured goods must in turn be shipped out. On the whole, therefore, it pays best in New England to manufacture the lighter and more

costly articles, such as cotton and woolen cloths, shoes, hats, clocks, jewelry, and thousands of articles sold in the department and drygoods stores. Factories for the making of shoes are particularly numerous around Boston, in fact, five out of six of the fore-

FIG. 287. — The New York Metropolitan District. Shaded area is New York City, made up of five boroughs. (*U. S. Census.*)

most shoe-manufacturing cities of the United States are in that section. Six out of the seven leading cotton-manufacturing cities are in or near eastern Massachusetts and Rhode Island; these are Lowell, Manchester, Fall River, New Bedford, Providence,

and Pawtucket. Woolen-manufacturing centers in Lawrence, jewelry making in and near Providence, silverware in Meriden, clocks in Ansonia, firearms in Springfield, hats in Danbury, paper in Holyoke, and so on through a long list. Southern New England is sprinkled over with manufacturing cities.

The New York Metropolitan District includes New York City and the immediately surrounding region (Fig. 287). The district includes small portions of Connecticut and New Jersey, as well as the southern point of New York, the western end of Long Island, and Staten Island. It is set thickly with cities — Yonkers, Jersey City, Newark, Passaic, Paterson, Hoboken, Elizabeth, Bayonne, and several others. In this Metropolitan District are about 20 cities of over 25,000 population; as many people live there as in the whole Dominion of Canada, and within its limits more goods are manufactured than in South America and Canada combined. There are several of our states and some foreign countries in which the total of manufactures does not reach 20 million dollars a year; in the Metropolitan District alone there are nearly fifty different articles each of which is manufactured to the value of 20 million dollars or more a year.

Near the water's edge, in both New Jersey and New York, are great sugar refineries which receive raw sugar by shiploads from the West Indies, the East Indies, Hawaii, Central America, and South America. There are enormous oil refineries, fed by hundreds of miles of pipelines reaching back into the oil fields (Fig. 34). There are great copper refineries receiving copper from Chile, Peru, Spain, Mexico, Asia, and any other part of the world where copper ore is mined. The products of these three groups of refineries alone are measured in hundreds of millions of dollars a year. About 40 per cent of the men's clothing and about 70 per cent of the women's clothing made in the United States are made in New York City. Indeed this one city now manufactures more goods than the entire United States manufactured in 1860.

In New Jersey's part of the Metropolitan District are seven large manufacturing cities and many others of lesser size. They

are all closely knit together and all closely joined to New York in their business interests. However, New York City alone produces more manufactured goods than are made in the rest of the Metropolitan District.

The Philadelphia-Baltimore District. — Philadelphia ranks third in total product among our manufacturing cities, yet in the com-

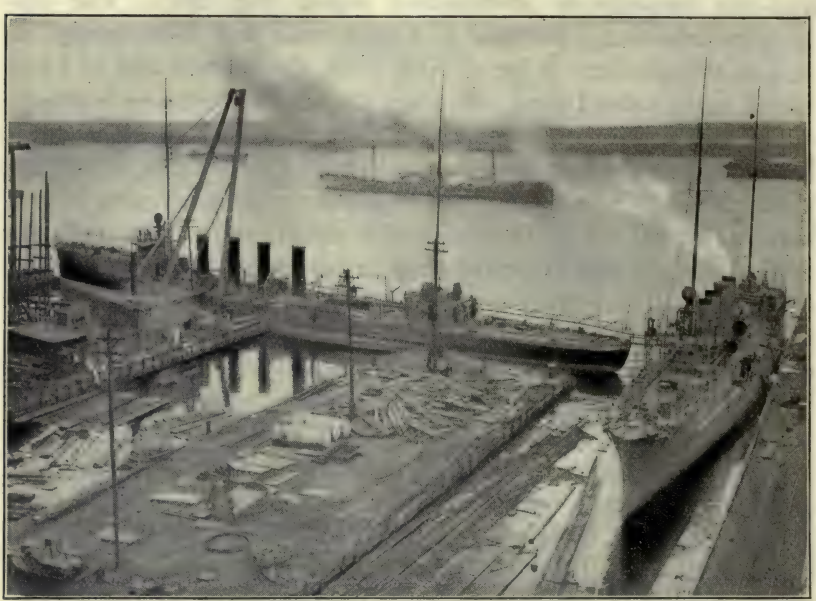


FIG. 288. — A small portion of Cramp's shipbuilding yards, Philadelphia. During the World War the Delaware became the leading shipbuilding river of the world.

pleteness with which its business interests gather around manufacturing, it may almost be given first place. Omitting our six foremost manufacturing states, Philadelphia makes more manufactured goods than the remaining forty-two states. In the making of carpets, rugs, and hosiery, it leads all the cities of the United States. Its oil and sugar refineries are among the largest in the country. The Philadelphia district includes cities on the Delaware from *Trenton* south. The leading city of Delaware is

Wilmington; in Maryland is the important port and manufacturing city of *Baltimore,* which ranks high among our great man-

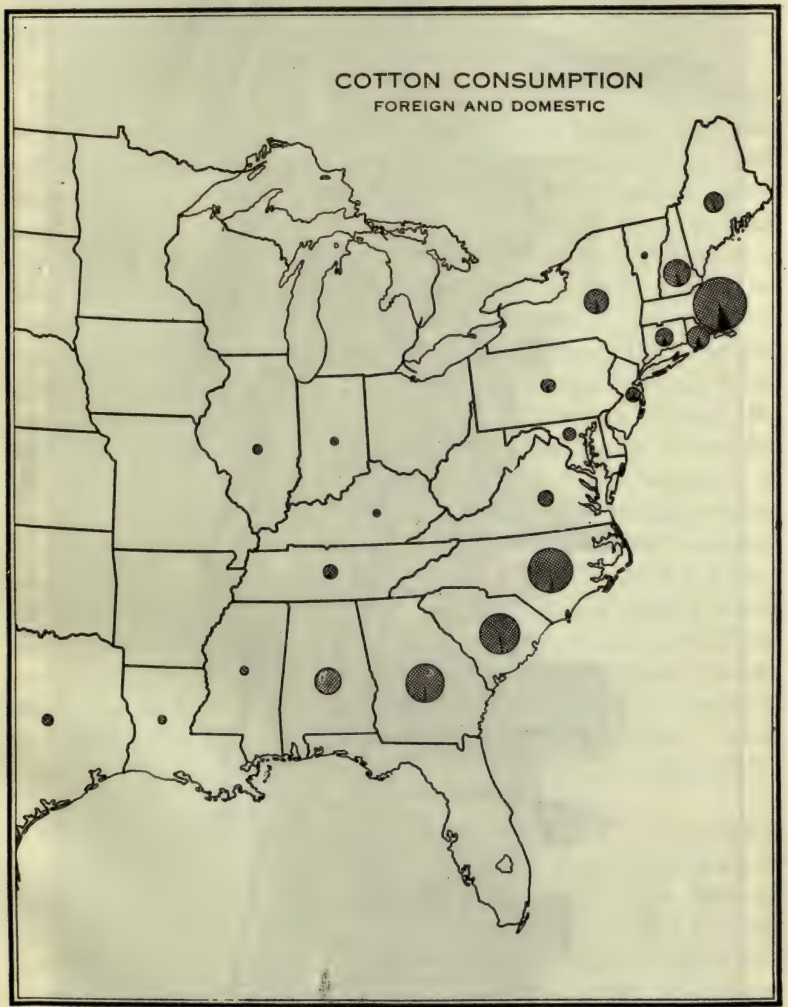
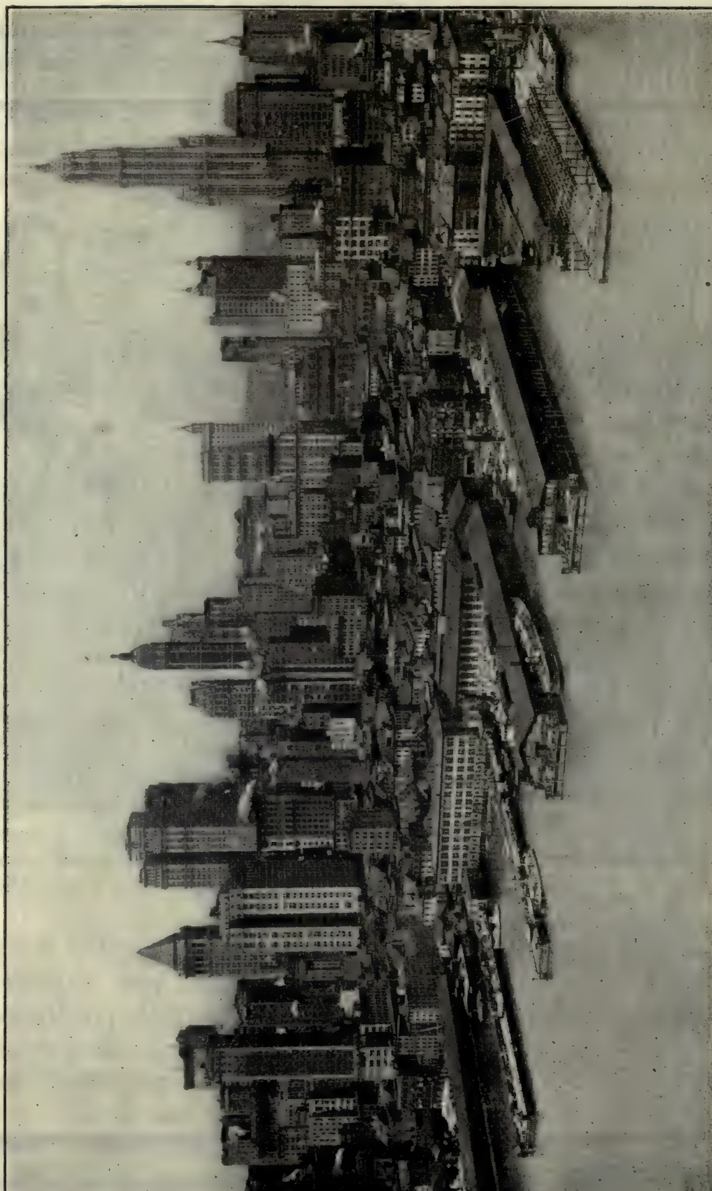


FIG. 289. — Principal cotton-manufacturing states. Areas of circles are in proportion to amount of cotton consumed in each state. (*U. S. Dept. of Agr.*)



(© Brown Bros.)

Fig. 290. — Lower New York.

ufacturing centers. Baltimore is usually classed as a southern city, and if so considered, it is the foremost manufacturing city of the South. It will be recalled that our principal shipbuilding yards, now the greatest in the world, are on the bays and rivers between the Hudson and the James (Va.) (Fig. 288).

Our Greatest Manufacturing Section. — It is a ten hours' ride by train from Boston to Baltimore, yet in that trip you will pass through ten important manufacturing cities and a half dozen others which, in most parts of the country, would be called large cities. If the journey were made by aëroplane on a clear day, you would pass almost in sight of factories which produce a third (in value) of the manufactured goods made in the entire United States.

The Pittsburgh Iron and Steel District. — This is the most important iron and steel center in the United States. At one time Pennsylvania was a leading state in the production of iron ore, and with coal and limestone at hand for smelting it, important iron industries sprang up. Later, the vastly richer deposits of ore near Lake Superior were found, and the cheap transportation of this ore by way of the Great Lakes enabled the iron industry to continue in the Pittsburgh district and in other parts of Pennsylvania where it was already rooted. The superior quality of the coke produced near Pittsburgh is one of the chief reasons for the growth of this vast industry in western Pennsylvania and eastern Ohio. Little by little, other steel-making centers are growing up, as at Buffalo, N. Y., Gary, Ind., Youngstown, Ohio, Chicago, Ill., Birmingham, Ala., Milwaukee, Wis., and Duluth, Minn.

Manufacturing in the North Central States. — It has been pointed out that manufacturing in the belt from Baltimore to Boston is remarkable for the great variety and the high value of the products. Only a small part of the raw materials used in these factories is produced in the East; they are brought from everywhere. But when we have crossed the Appalachian Mountains quite a different set of conditions is found. Most of the cities on the Great Lakes and in the states between the Lakes and the

Ohio River manufacture articles in which iron and steel figure very prominently. This is because the iron ore from the Lake Superior mines reaches this region cheaply by way of the Lakes and also because in these agricultural states a heavy demand for iron and steel products always exists. Here railroads, the largest users of iron and steel, are particularly numerous. It is a wealthy farming section where an enormous quantity of farm machinery and engines, wagons, automobiles, windmills, fence wire, and of all kinds of hardware is used. Illinois, for example, makes about 40 per cent of all the farming machinery manufactured in this country.

In the western half of this section, convenient to the grazing lands and the corn belt, slaughtering and meat-packing establishments are located in nearly every large city. *In value of products this is the leading manufacturing industry in the United States* (Fig. 291).

The states on the Great Lakes have long been the largest makers of all kinds of vehicles, and when the automobile came into use some of these carriage and wagon factories turned their experience and capital into the making of automobiles. *Detroit*, the chief center, makes upwards of one-fourth of all the automobiles made in the United States; one factory turns out three automobiles a minute. All of the leading centers of automobile manufacturing are in the states which touch Lake Erie and Lake Michigan (Fig. 292). The exceedingly rapid growth of Akron, Ohio, in recent years has been due to the rubber plants in that city; the largest use for rubber is now in the making of rubber tires.

The forests of Michigan and Wisconsin have given rise to many lumber mills, to pulp mills and paper mills, to tanneries, furniture factories, and scores of other wood-using industries (Fig. 293).

Chicago. — Chicago is the industrial and commercial center of the Middle West; it is the hub of the railroad systems of America, in fact, the greatest railroad center in the world, and it is surrounded by a wonderfully rich agricultural region. Its situation as a

manufacturing and distributing point is ideal, for it is within easy reach of coal, iron, lumber, copper, petroleum, cattle, hogs, and grain. Among American cities it ranks second only to New York in population, and holds first place in many important lines of

FIG. 291. — Slaughtered hogs in one of the great packing houses of Chicago. (*U. S. Dept. of Agr.*)

manufacturing, including meat-packing, machinery, cars, and blast furnace products (Fig. 294). The value of its manufactures exceeds the combined *total* of nineteen states of the Union; only five states manufacture more goods than this single city.

St. Louis. — This is the largest of the Mississippi River cities and is one of the half dozen greatest industrial centers of the United States. It has a wide range of manufactures, the leaders of which are boots and shoes, tobacco, and meat products. It has long been the chief distributing center for the Southwest.

Cleveland, *Detroit*, and *Milwaukee* (with Chicago) are the dom-

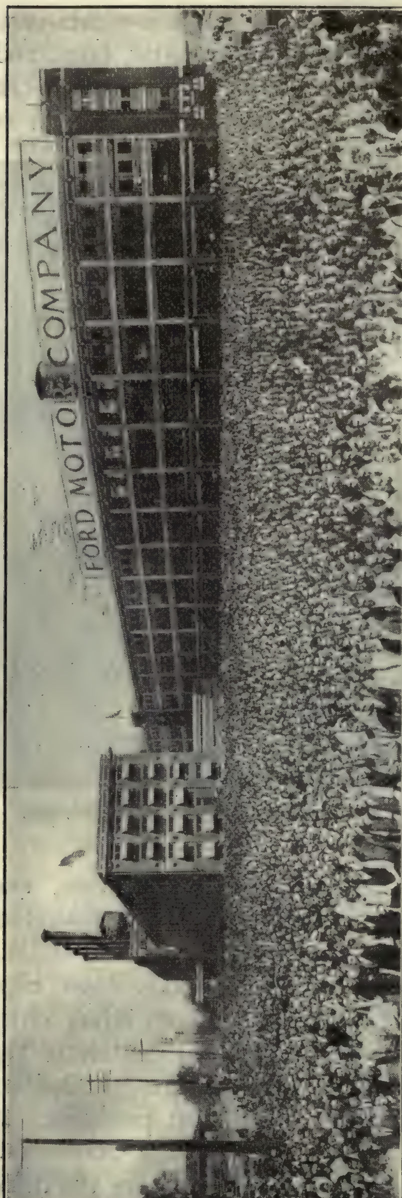


FIG. 292. — Part of the Ford Motor Co.'s plant and its 40,000 to 50,000 employees. This plant turns out three automobiles per minute. (*Courtesy Ford Motor Car Co.*)

inant manufacturing centers on the Great Lakes; all are large manufacturers of machinery and other products in which iron and steel are used. Milwaukee is also the second city in the United States in the tanning of leather.

Cincinnati and *Louisville* are on the southern margin of the iron- and steel-making region, and are primarily engaged in other lines of industry; Cincinnati is one of the large meat-packing and clothing centers, while Louisville is one of the leading tobacco markets of the United States.

Indianapolis is typical of the cities of the Middle West, with its meat-packing plants and its manufactures of machinery and automobiles. *Kansas City* (Kan.) and *South Omaha* (Neb.) are among the great meat-packing centers. *Kansas City* (Mo.) and *St. Paul* are prominent mercantile, banking, and railroad centers, with varied

manufactures. *Minneapolis* leads all in flour-milling and is the great lumber center of the Northwest.

Thus, it is evident that manufacturing in the north central states, unlike that in the eastern states, is notably dependent

FIG. 293. — One of the great lumber mills of northern Wisconsin. The greater part of the timber has been cut from the Great Lakes region and most of the great saw mills are gone. (*Courtesy N. W. Lumber Co.*)

upon raw materials which the section produces. It is to be noted, however, that in these states there are also great industries which are not dependent upon raw materials produced near by, as, for example, the shoe factories of St. Louis, the clothing factories of Chicago, the rubber industries of Akron, Ohio, and numerous other examples.

Manufacturing in the South. — As has already been stated, the people of the southern states have devoted themselves more largely to agriculture than to manufacturing. About 15 per

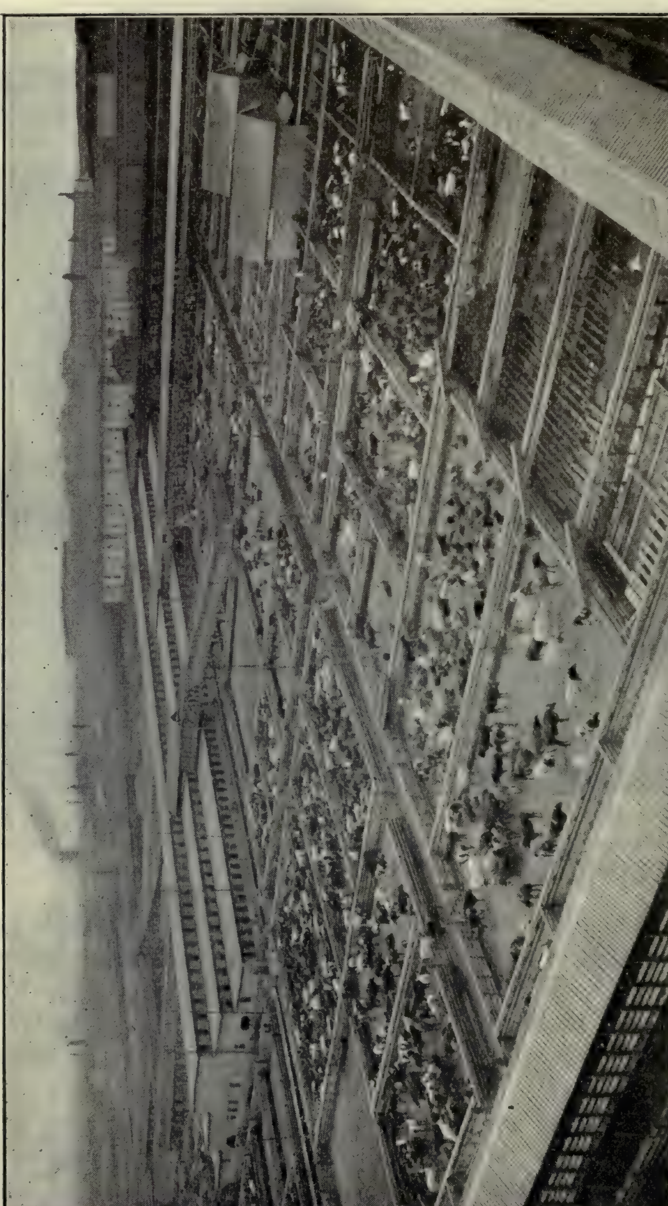


FIG. 294. — Portion of the Chicago stock yards. Chicago is the leading meat-packing city of the world.

cent of the manufacturing of the United States is done in the South; for some time past, however, manufacturing there has been

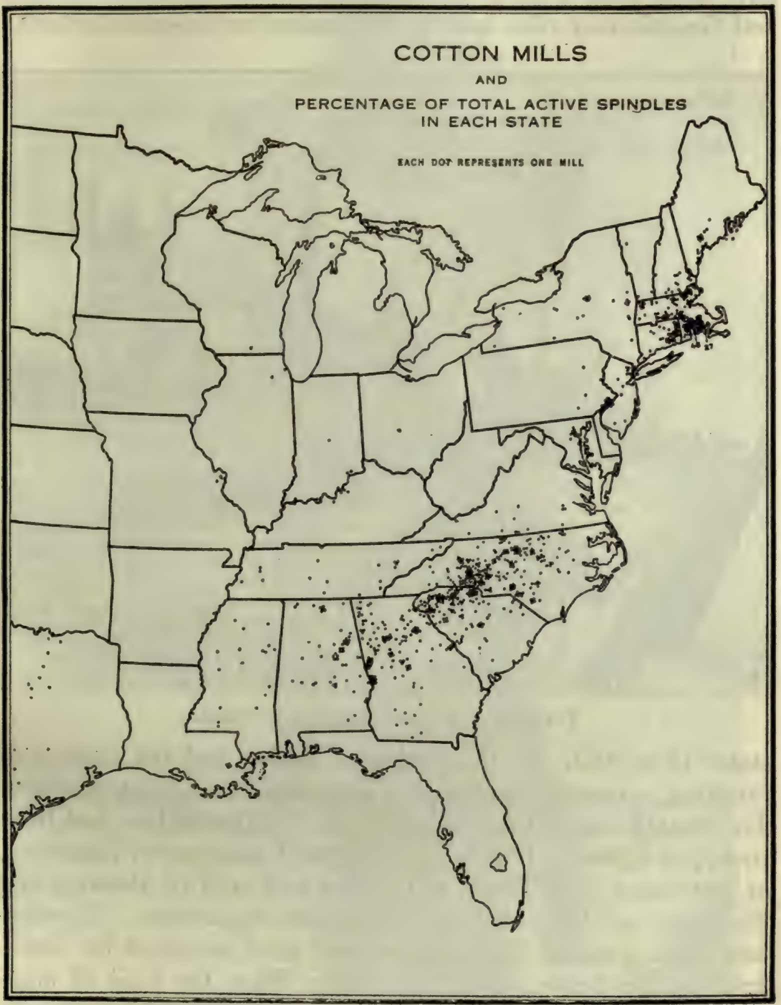


FIG. 295. — Distribution of cotton mills. They are nearly all east of the Appalachians. *(U. S. Dept. of Agr.)*

increasing. On the lower slopes of the Appalachian highland and along the Piedmont, where water power is abundant, cotton mills have been built in large numbers. North and South Carolina and Georgia now rank among the leading cotton-manufacturing

FIG. 296. — An iron smelter in Colorado.

states (Fig. 295). In the sawing of lumber and the making of furniture, several of the southern states hold important positions. The manufacture of tobacco in Virginia, North Carolina, and Kentucky, of cigars in Florida, of sugar and molasses in Louisiana, of cottonseed oil in Texas, and of iron and steel in Alabama and Tennessee are industries of nation-wide importance. *Birmingham,* Ala., is one of the rising iron and steel centers of the country. In the South, as in the Middle West, the kind of manufacturing depends largely upon the raw materials which the region produces; this fact is always true of a region in the earlier

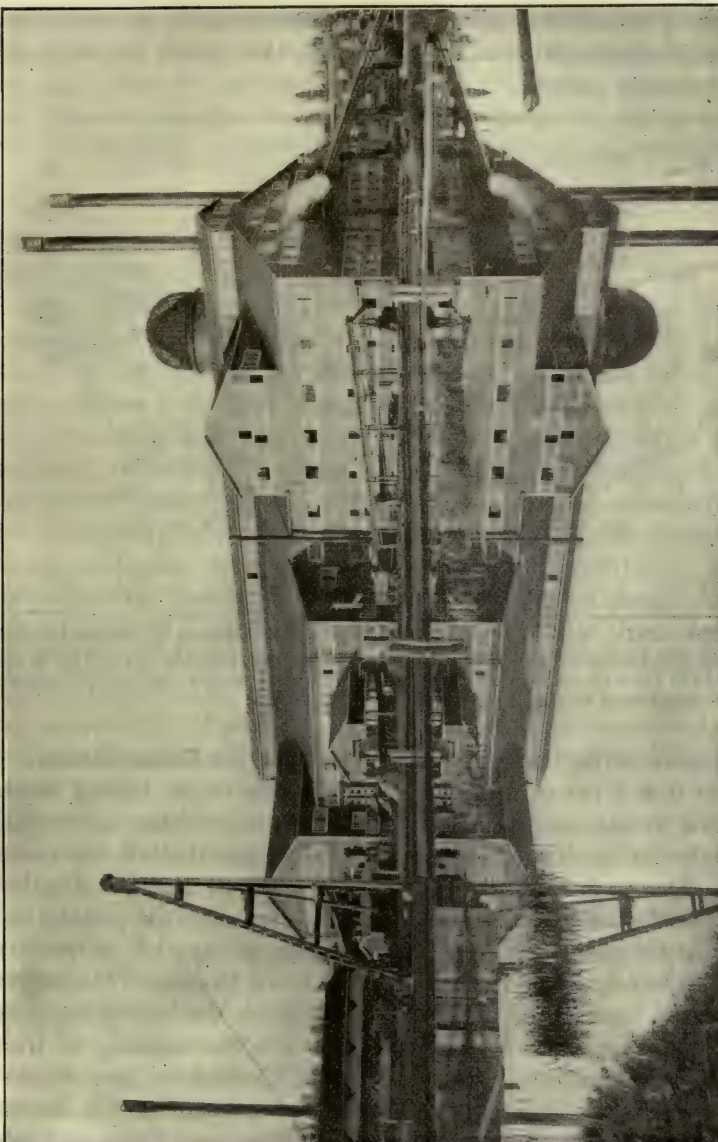


Fig. 297. — An immense saw mill in Idaho.

stages of manufacturing. Later, industries grow up which are not dependent upon local raw materials, as is clearly shown in the older eastern states.

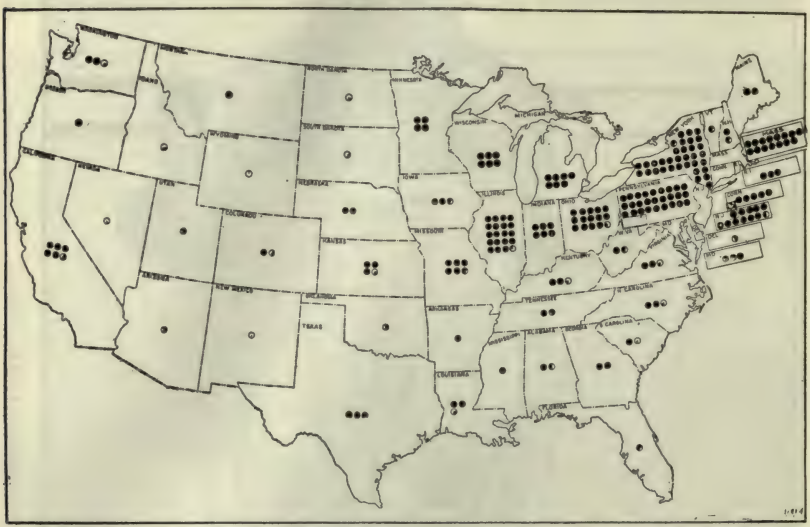


FIG. 298. — Map showing the distribution of manufacturing by states in 1910. Each dot represents $100,000,000 worth of manufactured goods. The figures for 1920 show about three times this value; approximately half of this increase, however, is due to higher prices.

Manufacturing in the Western Half of the United States. — About 6 to 8 per cent of the manufacturing of the United States is done in the mountain and Pacific states. Of the 50 leading manufacturing cities, 4 only are in the western half of the country. These are Denver, Seattle, San Francisco, and Los Angeles. Yet, in the value of manufactures per capita of the population, the Pacific states rank fifth in the nine groups of states into which the country is divided by the Census Bureau. The manufacture of lumber and other wood products is the largest industry in each of the three Pacific coast states. The canning of fruit in California, and of salmon in Oregon, Washington, and Alaska, are large industries (page 357). The smelting of ores is important near the great mining centers in Montana, Arizona, Utah,

Colorado, and other mountain states. Colorado has quite extensive iron and steel industries (Fig. 296), and the largest part of our beet sugar is made in Colorado and California. Oil refining in California has also risen to large proportions. It will be noted that all of these industries use the raw materials of the regions.

SUMMARY

It is convenient to divide the territory of the United States into four sections with respect to manufacturing:

1. *The Northeastern Section* is the oldest, most fully developed, and populous of the four sections; here, in a belt about 100 miles wide, reaching from Boston to Baltimore, an area no larger than Indiana, are located 21 of the 50 leading manufacturing cities of the United States. Here manufacturing depends but little upon raw materials produced in the region; the mills make an endless variety of goods, generally of high value in proportion to their bulk, and ship them to all parts of this country and abroad.

2. *The North Central Section*, lying between the Great Lakes, the Ohio, and the Missouri rivers, includes 24 of the 50 leading manufacturing cities (Fig. 286). It is particularly engaged in the manufacture of products in which the raw materials produced in the section are very largely used, such as iron and steel near the Lakes, lumber, paper, and other wood products in Michigan and Wisconsin, automobiles in Michigan, farming machinery in Illinois, flour in Minnesota, and meat products in all of the large cities.

3. *The South* is more largely an agricultural than an industrial section, but it is rich in raw materials, coal, and water power, and is steadily developing in manufacturing, notably in cotton goods, wood products, sugar, steel, and tobacco.

4. *The West*, mountainous, lacking in rainfall, and thinly populated, has as yet built up comparatively little manufacturing except on the Pacific slope, where a rapid industrial expansion is in progress.

EXERCISE XXV

Problems

1. Though Great Britain and France are old and in some ways more advanced than the United States, yet the manufactures of both together are much less in value than those of the United States. Give reasons for this.

2. From the *ten reasons* for the great development of manufacturing in the United States, given on page 404, select the five reasons which you regard as the most important, and tell why you selected them.

3. While the United States produces manufactured goods more than twice as great *in value* as Great Britain does, it has more than twice the population of Great Britain and more than 30 times the area. Which of the two countries should be ranked first *as a manufacturing nation?* Give your reasons.

4. Both Russia and China are larger and more populous than the United States; both have great natural resources, including coal and iron, and an invigorating climate. Why are they not prominent manufacturing nations?

5. Account for the fact that up to 1915 the United States *exported* fewer manufactured goods than Great Britain.

6. What is a tariff? A protective tariff? Why called "protective"? How does a protective tariff help to build up a nation's manufacturing industries? Does such a tariff make goods more expensive to the consumer? Be prepared to defend your answer.

7. Cheap fuel is almost a necessity in building up manufacturing industries, yet neither New England nor New York has coal deposits. Explain this apparent contradiction.

8. Suppose you desired to enter into some manufacturing enterprise on a large scale. In what part of the United States would you locate:

(*a*) a meat-packing plant? (*d*) a cotton mill?
(*b*) a paper mill? (*e*) a steel-making plant?
(*c*) a cane sugar refinery? (*f*) a silk mill?

Might there be several places equally advantageous for each of these? Explain. With respect to each of the above industries, name sections of the country where you certainly would *not* locate it. Give reasons.

9. The states of Ohio, Indiana, and Illinois, as a group, rank high in agriculture, in manufacturing, in mining, and in railway mileage. Give some of the reasons. Which one of the four is essential to the success of all?

10. Give reasons why the South has devoted less attention to manufacturing than the North. Why is manufacturing less developed in the West than in the East? Many people in the South do not desire mills and factories in their midst. Suggest reasons.

11. Give reasons for each of the following facts:

(*a*) Manufacturing has developed faster along the Great Lakes than along the Mississippi;
(*b*) on the shores of Lake Michigan than on the shores of Lake Huron;
(*c*) on the shores of Lake Erie than on the shores of Lake Ontario;
(*d*) along the Ohio than along the Missouri;
(*e*) on the Atlantic coast of the United States than on the Pacific coast.

PART TWO

[illegible]


THE WORLD
ON MERCATOR'S PROJECTION
Scale of miles along the Equator
0 1000 2000 3000 4000
ARCTIC OCEAN
ASIA
NORTH AMER
DOMINION
ALASKA
UNITED STA
PACIFIC OCEAN
OCEANIA
INDIAN OCEAN
ANTARCTIC OCEAN
AUSTRALIA
NEW SIBERIAN ISLANDS
ARCTIC CIRCLE
TROPIC OF CANCER
TROPIC OF CAPRICORN
EQUATOR
ANTARCTIC CIRCLE
DATE LINE
Monday
Sunday
Bering Sea
Okhotsk Sea
Japan Sea
JAPAN
HOKUSHU
HONSHU
Tokyo
CHOSEN
Vladivostok
Peking
Shanghai
Hongkong
Irkutsk
TAIWAN (FORMOSA)
PHILIPPINE ISLANDS
Manila
GUAM
YAP
LADRONE IS.
CAROLINE IS.
WAKE I.
HAWAIIAN ISLANDS
Honolulu
ALEUTIAN IS.
SAKHALIN
KAMCHATKA
KURILE IS.
Pt. Barrow
Nome
Juneau
VANCOUVER I.
Vancouver
Seattle
Winnipeg
San Francisco
Los Angeles
New Orleans
Mexico
COLON ARCHIPELAGO (GALAPAGOS IS.)
BORNEO
CELEBES
SUMATRA
Batavia
JAVA
EAST INDIES
NEW GUINEA
SOLOMON IS.
SAMOA IS.
FIJI IS.
NEW HEBRIDES
NEW CALEDONIA
Cooktown
Perth
Sydney
Melbourne
TASMANIA
Hobart
Auckland
Wellington
NEW ZEALAND
WILKES LAND
Williams Engraving Co., N.Y.
Longitude East
Longitude West

FIG. 298


ARCTIC OCEAN
FRANZ JOSEF LAND
SPITZBERGEN
GREENLAND
Baffin Bay
Upernivik
BAFFIN ISLAND
Davis Strait
NOVA ZEMBLA
Gulf of Ob
Yenisei R.
JAN MAYEN I.
North Cape
LOFODEN IS.
ARCTIC CIRCLE
ICELAND
Archangel
Hudson Bay
C. Farewell
CANADA
LABRADOR
BRITISH ISLES
North Sea
Liverpool
London
Berlin
Petrograd
Moscow
URAL MTS.
Ob R.
EUROPE
ASIA
Irtish R.
St. Lawrence R.
Ottawa
NEWFOUNDLAND
Paris
Vienna
Volga R.
Aral Sea
ALPS
Boston
New York
Chicago
Washington
Madrid
Lisbon
Rome
Black Sea
Caspian Sea
Constantinople
AZORES
Gibraltar
Mediterranean Sea
ATLANTIC OCEAN
BERMUDA IS.
MADEIRA IS.
ATLAS MTS.
Tunis
Alexandria
Cairo
Suez
HIMALAYA MTS.
Indus R.
Ganges R.
Delhi
CANARY IS.
TROPIC OF CANCER
Calcutta
INDIA
Mexico
BAHAMA IS.
CUBA
HAITI
PORTO RICO
CAPE VERDE IS.
Bombay
WEST INDIES
Caribbean Sea
C. Verde
Niger R.
Red Sea
Nile R.
Aden
Arabian Sea
Bay of Bengal
Colon
Panama
TRINIDAD
AFRICA
CEYLON
EQUATOR
Congo
Amazon R.
Para
INDIAN OCEAN
ASCENSION I.
Callao
SOUTH AMERICA
Bahia
ST. HELENA I.
Zambesi R.
Mozambique Chan.
MADAGASCAR
REUNION I.
Rio de Janeiro
TROPIC OF CAPRICORN
ANDES MTS.
Parana R.
Orange R.
Valparaiso
Cape Town
Buenos Aires
C. of Good Hope
KERGUELEN I.
FALKLAND IS.
MACDONALD IS.
SOUTH GEORGIA I.
Cape Horn
SANDWICH GROUP
ANTARCTIC OCEAN
ANTARCTIC CIRCLE
ENDERBY LAND
GRAHAM LAND
90° from 60° Greenwich 30° 0° 30° Longitude 60° East 90°

FIG. 298

CHAPTER XXI

LATIN AMERICA [1]

FROM the Rio Grande to Cape Horn stretches a vast area which was conquered and colonized by Spain and Portugal four centuries ago. About a hundred years ago these colonies revolted and, with the exception of Brazil, established republics. Brazil, the only Portuguese colony, established a monarchy, but in 1889 changed to a republic. European powers gained control of the various islands of the West Indies and still hold the majority of them. Latin America includes Mexico, the islands of Cuba and Haiti, six Central American and ten South American republics, in all of which, with the exception of Brazil and a part of Haiti, Spanish is the national language. The northern part of Mexico and the southern quarter of South America are the only portions of Latin America which are not within the tropics. In all the *tropical* countries except Cuba the colored races greatly outnumber the whites. This part of Latin America (Brazil excepted) was long afflicted with revolutions, corrupt governments, and backwardness generally; but improvement is going on and several of the countries including Cuba and Brazil and the temperate zone countries, Uruguay, Argentina, and Chile, are taking respected places in the family of nations.

[1] The countries of the western hemisphere south of the United States are referred to as Latin America because the people speak Spanish or Portuguese, which are based upon Latin. In this chapter the author has included, because of their situation, Porto Rico, Jamaica, the Panama Canal Zone, and a few small islands which belong to the United States or Great Britain.

Mexico

The Mexican People. — Over 80 per cent of the Mexican population is composed of Indians or mestizos (mĕs-tee′zōz); the latter are of mixed white and Indian parentage. Most of the white people are of Spanish descent and this small white minority owns the

Fig. 299. — Note how much of Mexico is a high plateau.

greater part of the land and holds most of the important offices. Eighty-five per cent of the people are poor and illiterate. The upper class of Mexicans includes people of high education, refinement, and wealth; but as a nation the Mexicans have not shown themselves able to maintain a stable republic.

The Country. — Mexico is a little over one-fourth the size of the United States and has a population of about 15,000,000, which is considerably greater than that of Canada. It is essentially a plateau bordered by high mountain ranges on either side (Fig. 299), and in the north is deficient in rainfall; the high altitude

makes the climate reasonably healthy and agreeable, but fully half of the land is of little use for agriculture.

Resources. — In minerals Mexico is exceedingly rich; it has yielded approximately $4,000,000,000 worth of minerals since the Spanish conquest four hundred years ago. It is one of

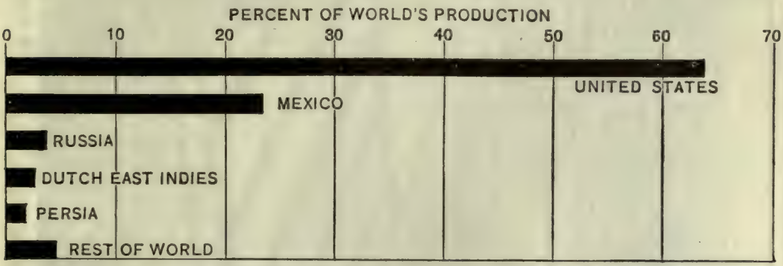


FIG. 300. — Percentage of the world's petroleum produced by different countries in 1921. Russia's production is far below normal and Mexico's production is rising rapidly.

the foremost silver-producing nations and an important producer of gold, copper, lead, and several other metals. On the other hand it is handicapped by the lack of coal, and very little iron is mined. One of the chief oil fields of the world is in eastern Mexico near Tampico and Tuxpam, and in the Isthmus of Tehuantepec. Mexico is now the second largest producer of petroleum (United States, Mexico, Russia). In 1921 there were 25 wells in Mexico capable of producing 600,000 barrels daily. The character of the oil and the nearness of the fields to the coast make the Mexican oil particularly desirable for oil-burning ships (Fig. 299).

Less than a quarter of the land is used for agriculture; and most of that is held in great estates which are poorly cultivated or are used for grazing. From 5 to 10 per cent of the land is covered with forests which contain valuable woods, but the timber is difficult to secure because of lack of transportation. In the peninsula of Yucatan are extensive areas which produce the fiber-producing plant called henequen; most of this (350,000,000 lb. a year) goes to the United States and is made into binder twine and other forms of cordage.

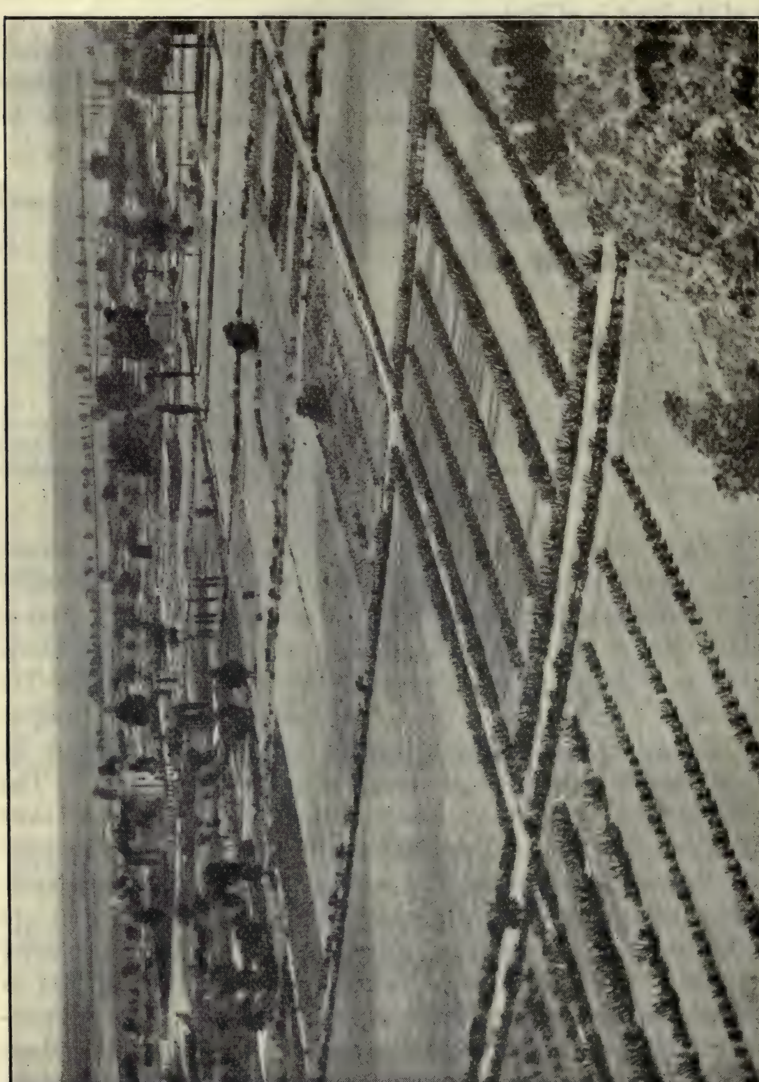


FIG. 301. — Agricultural lands on the plateau of southern Mexico. (© *Keystone View Co.*)

Industries. — The majority of the people live by means of primitive agriculture; corn is the chief food crop. A main cause of the chronic discontent among the people is that the land is nearly all in the possession of rich land-holders who treat the

FIG. 302. — Map showing that most of the larger cities of Mexico are at altitudes above 5000 feet. The figures indicate altitudes in hundreds of meters. (*Geog. Rev.*)

laborers (called peons) with scanty consideration. Mining is a great industry, but most of the large mining properties are owned by foreigners, especially Americans. The oil fields are mainly controlled by American and English capital, as are many of the cattle and sheep ranches. The Mexicans seem unable to develop the resources of their country and at times resent the intrusion of foreigners who seek to do so. There is some reason for their resentment and it is important that the United States treat Mexico with patience and justice. Manufacturing was making

some progress until the revolutionary period which began in 1910; but Mexico is likely to continue to import the bulk of the manufactured goods used by her people.

Means of Transportation. — The high mountains near the coasts make the building of railroads to the interior difficult and expensive, yet several lines with their branches have been built over these mountains. Mexico ranks third among Latin American countries in railway mileage. Several important lines cross the border from the United States and traverse the country from north to south. In normal times a through Pullman train runs between St. Louis and Mexico City.

Foreign Trade. — In peace times Mexico carries on a large trade with the United States which, because of its nearness, gets about two-thirds of that trade. Metals, oil, sisal fiber or henequen, coffee, and hides, are the chief exports. The imports are varied, but include manufactured goods, railway equipment, mining machinery, coal, and coke. Our trade with the 15 million people of Mexico is as great as that with the 400 million people of China, but less than that with the 3 million of Cuba.

Summary

While Mexico is in part a tropical country, it is made up of mountains and plateaus and the climate is not disagreeably hot in the highlands; it has enormous mineral wealth, especially silver, copper, lead, and petroleum. There are extensive, unused lands suited to agriculture and grazing, and the country has a favorable position for commerce, especially with the United States. The people lack capital and business ability; the land system is bad and a great majority of the people are landless and illiterate, and live by means of agriculture crudely carried on, or work for others; and, worst of all, Mexico has not been able to maintain a stable government. The larger enterprises are financed with foreign capital, most of which was invested before the last period of misgovernment demoralized the nation. Manufacturing has made only moderate progress. From one-half to three-fourths of the foreign trade is with the United States, and

cordial relations ought to exist between the two countries. When one notes the wonderful progress made by Cuba under a stable government he sees what might be done by Mexico — much richer, larger, and more populous — if the right kind of government existed there.

Central America

The neck of land which connects Mexico and South America is divided into six small republics and the little colony of British Honduras. The largest of the republics (Nicaragua) is about the size of New York State, and the most populous (Guatemala) has somewhat over 2,000,000 people. The republics are Guatemala, Honduras, Nicaragua, Salvador, Costa Rica, and Panama. Costa Rica and Panama are in advance of the other countries in nearly every way. All are tropical lands with dense jungles on the east (windward) side of the mountain system which extends through them. There is only one city having as many as 100,000 population; the people and the cities are mainly on the Pacific side, and in the highlands, where the altitude partially offsets the tropical heat. The great majority of the people are Indians and mestizos, mostly illiterate and thriftless. A small minority of the people are white descendants of old Spanish families; these and the foreigners own most of the land and conduct most of the enterprises. Agriculture is the principal occupation. Coffee plantations on the Pacific slope and banana plantations near the eastern coast are the chief sources of exports. Most of the coffee plantations are owned by Central Americans, but the large banana plantations are owned by Americans, notably by the United Fruit Company. (Forty per cent of the exported bananas of the world come from Central America.) Some of the large plantations produce upwards of a million pounds of coffee annually (Fig. 305). The United Fruit Company has over 100,000 acres of banana plantations in the Caribbean region and ships 40 to 50 million bunches yearly, mostly to the United States. There is very little manufacturing, few roads, and only a small railway mileage. Revolutions and disorders are frequent, yet slow progress is being made.

On a number of occasions a part or all of the Central American nations have attempted some sort of a confederation, but the

(© *Keystone View Co.*)

FIG. 303. — Native Indians and their home in Guatemala, Central America.

The Federated Republic of Central America, formed in 1921, is made up of Guatemala, Salvador, and Honduras

FIG. 304

attempt has not succeeded. In 1921, three of the countries — Guatemala, Salvador, and Honduras — formed a new union, but its success is problematical.

Panama, which became independent of Colombia in 1903, has

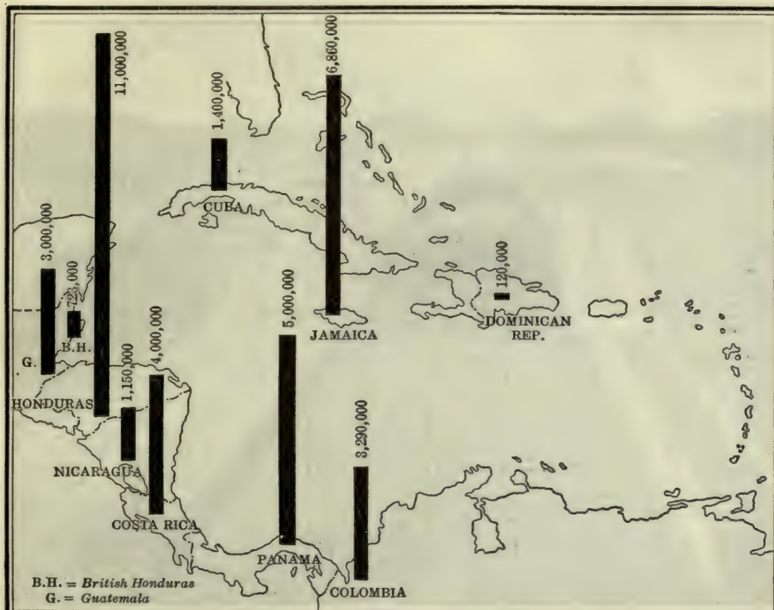


FIG. 305. — Number of bunches of bananas shipped to the United States from various Caribbean countries in 1920.

an orderly government and is in a prosperous condition. The United States is in possession of the Canal Zone, a strip five miles wide on each side of the Panama Canal.

The Panama Canal (Fig. 304). — This is one of the great engineering triumphs of the United States. A French company attempted to construct a canal at Panama, but after expending millions of dollars and sacrificing thousands of lives to tropical diseases, the company became bankrupt and finally sold its rights to the United States, which began work on the canal in 1904 and opened it for traffic in 1914. It is about 50 miles long, and has

three pairs of locks near each end; it has already cost over $400,-000,000. Vessels carrying passengers or cargo pay a toll of $1.20 per ton for passing through the canal; vessels in ballast pay less. The canal is of great value to the United States for both military

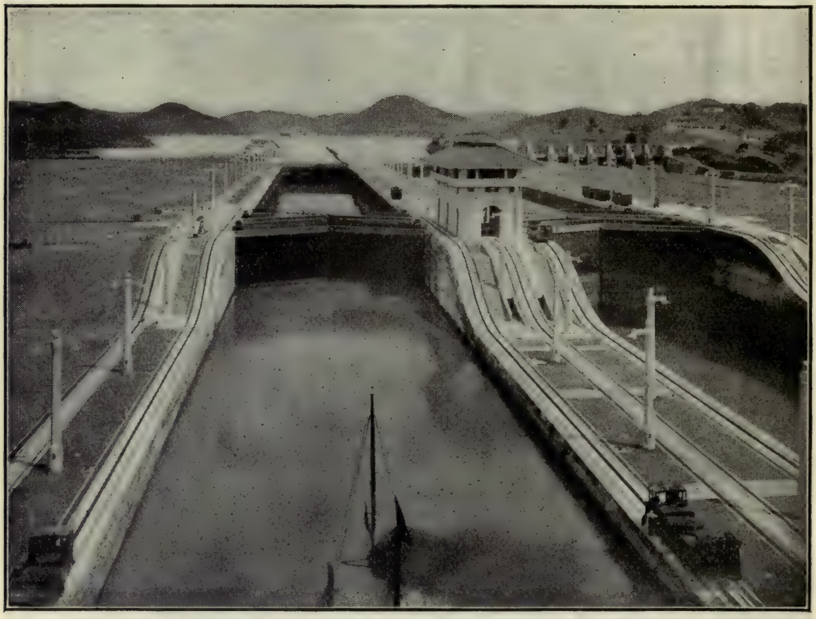


FIG. 306. — Miraflores locks in the Panama Canal.

and commercial reasons. Between 3000 and 4000 ships pass through the canal yearly, and the income from tolls pays the cost of operation but does not pay off any of the cost of construction.

THE WEST INDIES

This large and important group of islands is made up of the Greater Antilles and the Lesser Antilles (Fig. 304). Four of the largest islands compose the Greater Antilles: Cuba, Haiti, Jamaica, and Porto Rico.

Cuba is an independent republic under the guardianship of the United States. In length it would reach nearly from New York

to Chicago. It is as large as Ohio and has a population of over two and one-half millions. Havana, the capital and chief port, is a stirring city of four hundred thousand people. Cuba has become one of the most stable and prosperous of the Latin American

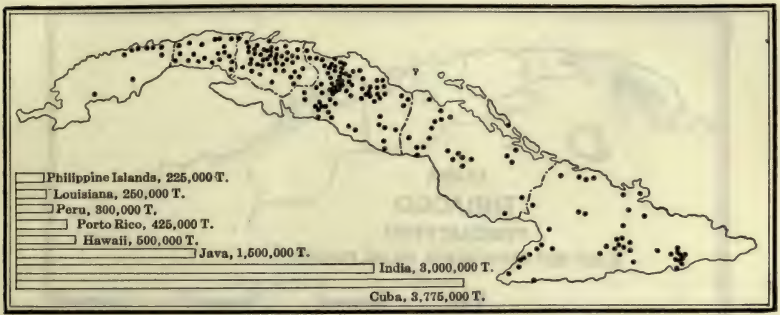


FIG. 307. — Map showing the locations of the 200 sugar mills of Cuba. The bars represent the average annual production of sugar in the leading cane sugar producing countries.

countries. Its great crop is sugar cane, of which it is the world's leading producer (Fig. 307). The raw sugar is made from the sweet juice of the cane extracted by grinding and pressing. The juice is boiled and the raw sugar crystallizes out. Most of the raw sugar comes to the United States, where it is refined and consumed.

The other important crop is tobacco, raised in the western end of the island and regarded as the choicest cigar-making leaf in the world (Fig. 309). The principal mineral product is iron, mined in the eastern end of the island; most of this goes to iron works in Maryland. Cuba's commerce, remarkably large for a country of its size and population, is mainly with its near neighbor, the United States, as is also true of Mexico and in large degree of Canada.

Haiti. — This island has two republics, Haiti and the Dominican Republic, badly governed and very backward; the people are practically all negroes. Tropical agriculture is the principal industry, and sugar and cacao the principal crops.

Jamaica, the size of Connecticut, belongs to Great Britain; the upper official positions and the larger financial enterprises are mainly in the hands of the white residents, but over 90 per cent of the people are negroes, descendants of former slaves.

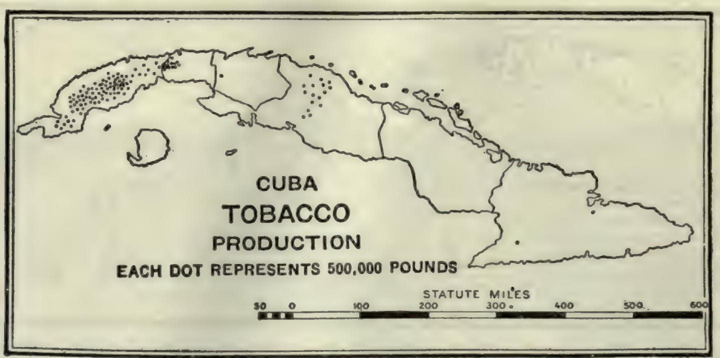


Fig. 309. — Where the Cuban tobacco is grown. (*U. S. Dept. of Agr.*)

Formerly Jamaica was a very large producer of sugar and, later, of bananas, but destructive hurricanes ruined many of the plantations; the exportation of bananas dropped from 16 million bunches in 1914 to less than 3 million in 1919, but gradually rose again in following years. The capital, *Kingston,* has an excellent harbor and is one of the principal naval stations of Great Britain in the West Indies.

Porto Rico formerly belonged to Spain but became a possession of the United States after the Spanish-American War (1898). It is nearly three times the size of Rhode Island and has over a million people. It is largely self-governing and sends a commissioner to the United States Congress. About two-thirds of the Porto Rican people are white and one-third colored. Sugar is the big crop and forms two-thirds of the value of all exports. Coffee, tobacco, and pineapples are also characteristic products. There is little manufacturing or mining, but the foreign trade is very large per capita.

The Virgin Islands. — Near Porto Rico are three small islands called the Virgin Islands, purchased by the United States from


CARIBBEAN SEA
ATLANTIC OCEAN
PACIFI
CENTRAL AMERICA
LESSER ANTILLES
GUADELOUPE (Fr.)
DOMINICA (Br.)
MARTINIQUE (Fr.)
SANTA LUCIA (Br.)
BARBADOS (Br.)
TRINIDAD (Br.)
Port of Spain
CURACAO (Dutch)
Gulf of Venezuela
Pt. Gallinas
La Guaira
Caracas
Puerto Cabello
Barranquilla
Cartagena
Gulf of Darien
ISTHMUS OF PANAMA
Colon
Panama Canal
PANAMA
Panama
Gulf of Panama
Delta of the Orinoco River
Georgetown
New Amsterdam
Paramaribo
St. Laurent
Cayenne
BRITISH
DUTCH
FRENCH
GUIANA
VENEZUELA
Orinoco R.
SIERRA PACARAIMA
SIERRA PARIMA
COLOMBIA
Medellin
Bogota
Manizales
Cali
Buenaventura
Cauca R.
Magdalena R.
Yapura
Equator
Quito
Mt. Antisana
Mt. Cotopaxi
Mt. Chimborazo
Guayaquil
Gulf of Guayaquil
ECUADOR
Cuenca
Napo
In dispute
Putumayo R.
Iquitos
Amazon
Maranon
Ucayali
Javari R.
Jurua R.
Purus R.
Madeira R.
Jamary
Teodoro R.
Rio Negro
Manaos
Amazon
Obidos
Santarem
Tapajos R.
Xingu
Peru R.
Jary R.
Oyapok R.
Mouths of the Amazon River
Para R.
MARAJO I.
Para (Belem)
Maranhao (Sao Luiz)
Granja
Ceara
Cape St. Roque
Natal
Parahiba
Pernambuco (Recife)
Maceio
Joazeiro
Parnahiba R.
Tocantins
Araguaya R.
Sao Francisco R.
Bahia
Porto Seguero
Caravellas
Diamantina
Goyaz
Plateau of Matto Grosso
Matto Grosso
Arinos R.
Guapore R.
BRAZIL
Cerro de Pasco
Lima
Callao
Oroya
PERU
Cuzco
Arequipa
Mollendo
Arica
L. Titicaca
Mt. Sorata
La Paz
Mt. Illimani
Mamore
Cochabamba
Oruro
BOLIVIA
80°
70°
60°
50°
40°
10°
0°
10°


SOUTH AMERICA
POLITICAL MAP
Scale of statute miles
0 100 200 400 600 800 1000
Capitals of Countries
ATLANTIC OCEAN
OCEAN
ARGENTINA
CHILE
PATAGONIA
PARAGUAY
URUGUAY
Tropic of Capricorn
Iquique
Antofagasta
Victoria
Petropolis
Sao Paulo
Santos
Cape Frio
Nictheroy
Rio de Janeiro
Rio Grande
Parana
Porto Alegre
Salta
Asuncion
Tucuman
Corrientes
Santiago del Estero
Salado R.
Pilcomayo R.
Uruguay R.
Cordoba
Santa Fe
Parana
Mendoza
Mt. Aconcagua
Valparaiso
Santiago
S. Fernando
San Luis
Rosario
Salto
Buenos Aires
Montevideo
La Plata
Plata R.
C. San Antonio
C. Corrientes
Talca
Concepcion
Chillan
Colorado
Bahia Blanca
Blanca Bay
Valdivia
Rio Negro
Puerto San Antonio
Castro
CHILOE I.
Chubut R.
CHONOS ARCHIPELAGO
Gulf of Penas
JUAN FERNANDEZ IS. (To Chile)
QUEEN ADELAIDE ARCHIPELAGO
Strait of Magellan
Punta Arenas
TIERRA DEL FUEGO
Cape Horn
FALKLAND ISLANDS (British)
SOUTH GEORGIA I. (British)
SANDWICH IS. (British)
110° 100° 90° 80° Longitude 70° West 60° from 50° Greenwich 40° 30° 20° 10°
20° 30° 40° 50°
WILLIAMS ENGRAVING CO. N.Y.

FIG. 308

Denmark in 1916 for $25,000,000. They are unimportant except as they may strengthen our naval position in the Caribbean.

The Lesser Antilles. — These belong to various European powers, especially Great Britain and France. They were once important producers of sugar; now they yield various tropical products, such as cacao, coffee, and coconuts, but they are less valuable as colonies than they were formerly. The island of Trinidad, a British colony near the coast of South America, has an asphalt lake which is one of the chief sources of our natural asphalt.

The Bahamas are a group of coral islands belonging to Great Britain not far from the coast of Florida.

On the map (Fig. 304) locate all of the countries and islands named above.

SOUTH AMERICA

The Outstanding Physical Features

1. An Exceptionally Regular Coast Line. — South America has an unusually regular coast line; there are no peninsulas of note and no large indentations. Only the coast of southern Chile is irregular; this section has fiords and many islands, resembling the coast of southern Alaska. There are almost no good harbors on the west coast except in the southern half of Chile. On the whole, eastern South America has sufficient natural harbors for its commercial needs, but the harbors on the west coast are so open to the sea that they give little protection to ships in times of storm.

2. The Andes Mountains. — This mountain system, studded with active volcanoes, is one of the most lofty mountain barriers in the world. It is made up of two or three main ranges broadening into an extensive plateau in Bolivia. Its highest peaks exceed 20,000 feet, and for the greater part of its length the lowest passes are between two and three miles above sea level. This frowning mountain wall, rising from the very edge of the continent and traversing its entire length, is one of the most difficult of the great mountain systems of the world for roads and

railroads to cross. This barrier acts as a powerful influence in retarding the development of the countries on the west coast, especially those north of Chile.

3. The Northern and Eastern Mountains. — These are much older and much more worn down by the agents of waste than are the Andes. In southeastern Brazil they rise from near the water's edge to a height of 2000 feet and more. Their height somewhat offsets the tropical heat and improves the climate of this part of Brazil. The great coffee plantations are on the plateau back of Rio de Janeiro and Santos.

4. The Three Great River Basins. — The largest of these, the Amazon, has already been described (page 150). The *Orinoco,* mainly within the boundaries of Venezuela, is navigated for a few hundred miles; the broad grassy plains, called *llanos,* on either side form natural pasture lands, but they are only partially utilized. The group of rivers which unite to form the *Rio de la Plata* is nearly as important as the Amazon system; these include the *Parana,* the *Paraguay,* and the *Uruguay.* Both the Amazon and the *Rio de la Plata* systems are more used for navigation than are rivers in the United States; this is partly due to the fact that railroads are much less common in South America.

Summary of the Surface Features

(1) An exceptionally regular coast line; (2) a lofty mountain wall forming an effective barrier along the entire west coast; (3) a vast extent of swampy, jungle-covered plains forming the Amazon basin; (4) extensive grassy plains in Venezuela and southern Brazil, and more important ones in Uruguay and Argentina; (5) large areas of worn-down mountains in eastern Brazil, important in their effect upon temperature and upon the coffee industry; (6) three great river systems, two of which are much used for navigation.

South America Contrasted with North America

1. Size. — The difference in size is not particularly important, although North America is about 15 per cent larger than its southern neighbor.

2. Situation. — The difference in situation is of utmost importance for most of North America is in the temperate zone, while about three-fourths of South America is in the torrid zone.

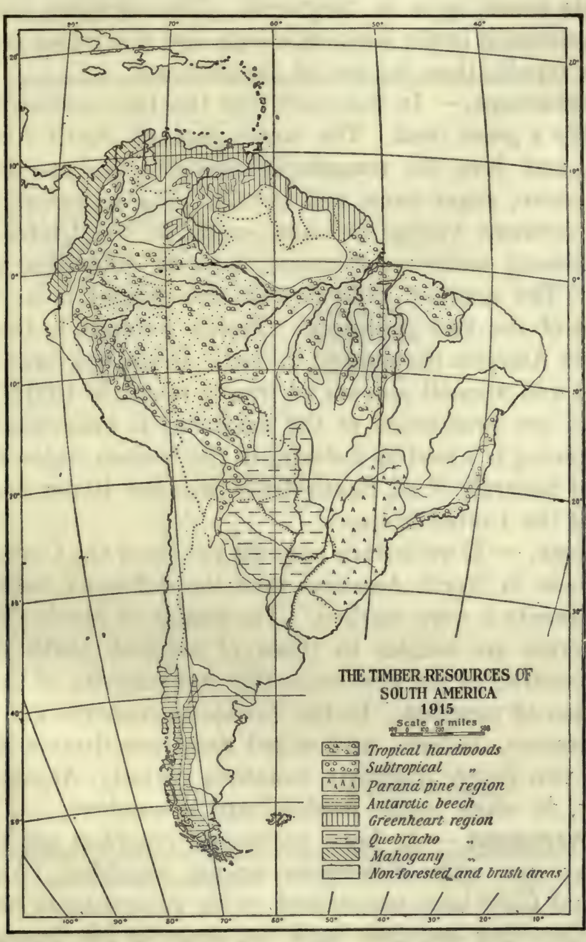


FIG. 310. — Forest regions of South America. (*Zon, in Geographical Review.*)

3. Climate. — The difference in climate is very marked. In the torrid zone changes of seasons are less important than in the tem-

perate zone. The hot, sultry climate of the tropical lowlands robs men of their energy, makes work irksome, and retards progress generally. All of the great nations of the world are in the temperate zones, none in the torrid. The southern quarter of South America is in the temperate zone and this region is advancing more rapidly than the rest of the continent.

4. Productions. — In this particular the two continents naturally differ a great deal. The larger part of South America is tropical, and here the commercial products are mainly coffee, rubber, cacao, sugar cane, and cotton. The temperate portion of the continent yields the same crops as the United States. The mineral products, of course, have no connection with the climate. The greatest difference in this respect is in the coal resources of the two continents. North America is the richest and South America the poorest in coal. Brazil has large iron ore resources and a small amount of iron is mined in Chile, but the total iron ore production of the continent is insignificant. Although mining is a leading industry in the Andean region the total output of minerals of all South America is not 10 per cent of the output of the United States.

5. People. — If we include only the people of the United States and Canada in North America, then the difference between the two continents is very marked. The people of Mexico and Central America are similar to those of tropical South America. In the countries of the west coast the vast majority of the people are Indians or mestizos. In the Caribbean countries and tropical Brazil, negroes, Indians, and mixed races constitute a majority. Only in two South American countries, namely, Argentina and Uruguay, do white people predominate in numbers.

6. Government. — In both continents republics are the rule, yet there are wide differences among republics. Argentina, Brazil, and Chile have maintained stable governments for a long time. The other countries have had more or less frequent revolutions and their governments are none too stable. Education for the common people is in a backward state. In quality of government and in general welfare the best South American coun-

tries are behind the United States and Canada, and the other countries are very far behind. Bad government deters men from investing their capital in mines, railroads, or factories, and so retards business development. This is a serious drawback in several countries, but the condition is gradually improving.

FIG. 311. — Approximate population of each of the South American countries.

7. General Development. — The conditions in North America are far in advance; in only a few parts of South America has railroad building made much headway, and good roads are scarce. Less manufacturing is done in all South America than is done in

Illinois. Though mining is an important industry in the Andes, the total mineral output of the continent does not equal in value the output of coal from the mines of Pennsylvania alone. More money is expended on education in New York State than in all the countries of South America combined.

Countries Bordering the Caribbean

The Caribbean countries are Colombia and Venezuela, and we might add the three colonies, British Guiana, French Guiana, and Dutch Guiana, though they are somewhat east of the Caribbean. All are tropical and backward (Fig. 311). Colombia and Venezuela have been retarded by frequent revolutions and a prevailing instability of government.

Colombia. — This country is larger than France and Germany combined. It formerly included Panama, which in 1903 became an independent republic. The tropical heat is intense in the lowlands, and so the greater part of the white people live in the highlands several thousand feet above the sea level. Bogota, the capital, is situated far inland at an elevation of over 8000 feet. Less than 10 per cent of the people are pure whites, but these form the educated, well-to-do, governing class. Half of the country is tropical jungle belonging to the Amazon basin and is sparsely inhabited by Indian tribes. The Magdalena River, navigated by river steamers, is the chief route, but a slow one, into the interior. Links of railroad connect navigable parts of the Magdalena and extend to Bogota; one railway also connects with the Pacific coast. In all, the country has 700 miles of railway, but only a few roads for wheeled vehicles. Trails, followed by pack animals, are the chief highways. There are banana, sugar, cacao, and coffee plantations, but only a small fraction of the country produces commercial crops. Coffee is by far the most important product, forming 50 per cent of the total exports of the country. Ivory nuts, emeralds, platinum, cattle, and gold form exports of considerable value. There are about 5,000,000 people in the country, the majority of whom carry on agriculture to the extent of

supplying their simple needs and providing a limited amount for export. Though Colombia is the largest gold producer among South American countries, its annual output reaches only 6 or 7 million dollars. Colombia is one of the two countries that produce

FIG. 312. — Digging asphalt from the surface of the asphalt lake in the island of Trinidad. (© *Pub. Photo. Service.*)

most of the world's platinum, though Colombia's part is only 6 per cent against Russia's former 93 per cent; it is also the chief producer of emeralds. Iron and coal exist but are mined very slightly. The value of the coffee produced is much greater than that of all the minerals combined. There is but little manufacturing, and the total foreign trade is only about one-tenth that of Cuba.

Venezuela. — This unfortunate, misgoverned country has more than three times the area of the British Isles and has a popula-

tion under 3,000,000, less than 10 per cent of whom are whites. The colored people include negroes, Indians, and mixed races. Repeated revolutions with much destruction of property have occurred. The country has extensive areas of grazing lands, but the cattle industry has been retarded by the many internal wars. The most important crop is coffee, grown on hundreds of plantations and making up more than half of the total exports of the country. A little gold and copper is mined and a little petroleum and asphalt is produced, but the mineral output is small (Fig. 312). There is no manufacturing of note. The total railroad mileage is 600 to 700 miles and there are almost no roads except trails. Both the producing and the consuming power of the country is small, hence the foreign trade is small. Both Colombia and Venezuela carry on the larger part of their trade with the United States.

The Guianas. — These three tropical colonies belong respectively to Great Britain, Holland, and France. Only a very small fraction of the people are white. British Guiana is the most prosperous, yet only one acre in three hundred of the land is cultivated; the population is near the coast; the interior is tropical jungle with some grassland. Sugar cane and rice are the only crops of importance. Dutch Guiana once belonged to Great Britain; in 1667 it was traded to Holland for New Amsterdam, now New York. The total population of Dutch Guiana is scarcely 100,000, more than half of whom live in or near the capital, Paramaribo. French Guiana is the least important of the three colonies; its total population is around 50,000.

THE WEST COAST OF SOUTH AMERICA

Unfavorable Conditions. — The countries of the west coast, north of Chile, are seriously handicapped by five unfavorable conditions:

1. As already pointed out, each is traversed by a lofty and unbroken mountain system. There is only a narrow coastal plain, and such lowland as does exist between the sea and the mountains in Colombia and Ecuador is hot and unhealthful.

2. The people must choose between living near the coast in a tropical lowland and going up among the mountains, where the temperature is moderate but where other conditions are unfavorable for carrying on various industries. There is little agricultural land. The roads are merely trails or mule paths. Railroads are few and very costly to build and maintain. Not as much manufacturing is done in the five Andean countries as is done in a city like Cleveland. Most of the industries that do exist are conducted on a small scale; mining is a partial exception to this.

3. From Peru to central Chile (2000 miles) the rainfall is so light on the Pacific side of the mountains that the country is a desert, while in eastern Peru and Bolivia the rainfall is so heavy that dense tropical jungles cover the mountain slopes and plains. The total agricultural exports from Colombia, Ecuador, Peru, Bolivia, and Chile do not equal the productions of a single one of our good farming states, such as Ohio or Illinois.

4. Only a small proportion (less than 10 per cent) of the people are pure whites. As a rule this white population (mostly of Spanish descent) has the education, holds the offices, and owns most of the property; while a large majority of the lower classes are in a state of poverty and ignorance and many are peons or near-slaves.

5. The governments have been unstable, revolutions have been frequent, and popular education is neglected; the men of the ruling class have not had the sort of training that fits them to carry on large enterprises; and so mining, railroad building, and most other lines of development on a large scale have been accomplished by Americans and Europeans.

Mineral Resources. — Peru and Chile have the largest copper mines in South America; Bolivia is the only important source of tin in either America; most of the Andean countries produce silver, Peru being the leader. In the desert of northern Chile are the largest deposits of nitrate (nitrate of soda) in the world. In fact Chile furnishes the world's supply of this salt. It is found in beds at or near the surface of the ground; it is loosened by the use of explosives, is purified by dissolving out the nitrate and re-

moving the earthy matter, is bagged, shipped to the coast, and exported. In peace times it is mainly used for fertilizer and in war times for the manufacture of explosives. These nitrate beds are the richest known mineral deposits in South America, and

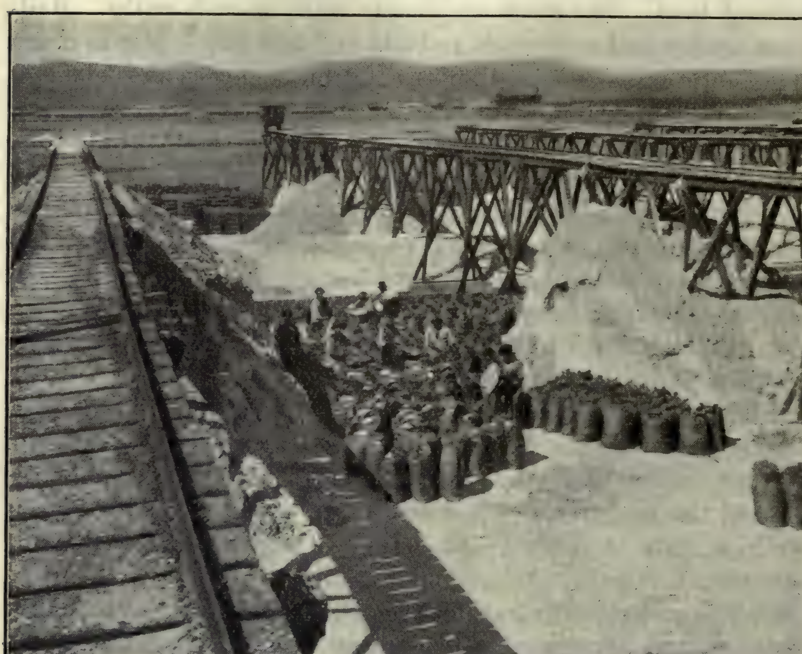


FIG. 313. — Sacking nitrate in Chile. (© *Keystone View Co.*)

the export tax collected on them supplies the chief source of income for the Chilean government (Fig. 313). Off the coast of Peru are islands upon which were enormous deposits of guano, the exports of which during forty years were valued at over $400,000,000. This valuable fertilizer is still exported, but in restricted quantities.

Chile mines a small amount of iron ore, and has the only coal mines of importance in South America. No other country in South America mines any coal for export, and even Chile imports more than it exports. Coal is reported to exist in Colombia and a

poor variety in Brazil; a small amount is mined in Peru and is mostly used by the copper smelters near by. One of the great drawbacks to the development of South America is this lack of coal. The railroads and manufacturing plants are largely dependent upon imported coal, which has become very costly.

The amount of gold and silver taken from western South America by the Spanish conquerors amounted to hundreds of millions of dollars; in fact, the Spaniards directed their efforts mainly to mining the precious metals. They did little to develop the colonies or to improve the Indians, whom they treated with cruelty unbelievable.

Lest an incorrect impression of the mineral production of South America be given, it may be pointed out that the annual output of gold in all South America is less than that of Cripple Creek, Col.; of copper, is less than that of any one of our leading five districts; of silver, tin, iron, coal, and all other minerals, including nitrate, is less than the value of the iron ore mined in the Mesabi Range in Minnesota.

Agriculture. — In western South America, as in nearly all countries which are in the early stages of development, agriculture and stock raising are the chief occupations of the people. The countries are so mountainous and means of transportation are so imperfect that the majority of the communities produce little more than enough for their own needs. Cacao beans, from which chocolate is made, form the chief export of Ecuador. A small part of the coast land of Peru is irrigated and produces abundantly. Plantation agriculture is here practiced, mainly with foreign capital. There are large sugar and cotton plantations; the value of the sugar exported is greater than that of all other Peruvian food crops (Fig. 314). These are about the only coast lands from Panama to central Chile where agriculture really thrives, and here it is due to irrigation; for nearly 2000 miles this coast is practically desert.

Such grazing animals as the llama, alpaca, and sheep are raised in the highlands and a part of the wool gets into international trade. The mountain lands produce little more food than the

FIG. 314. — Irrigated areas along the coast of Peru. The greater part of the agricultural exports of Peru come from these irrigated lands. (*Am. Geog. Soc.*)

natives require. The vast majority of the natives are wholly ignorant of modern methods of agriculture.

Nothing need be said of agriculture in Bolivia, where less than six per cent of the people are whites. The northern third of Chile is a desert and the southern third is made up of forested or snow-covered mountains. The central third includes the Vale of Chile, a beautiful valley much like that of California. Here agriculture is carried on by modern methods. All of the crops of the middle temperate zone are raised, and several million bushels of cereals (wheat, oats, barley) are exported yearly. This valley and the irrigated patches in Peru are the only agricultural lands on the west coast that deserve mention.

Transportation. — Roads for wheeled vehicles are very rare in these countries except in the valley of Chile. A winding railroad climbs up from the port of Guayaquil to Quito, the cap-

ital of Ecuador. Peru has two lines connecting the coast with the interior, and also a number of short lines, a total of nearly 2000 miles. Bolivia is penetrated by a railroad from Peru and two from Chile, and another from Argentina enters from the south. Chile is reasonably well supplied with railways, particularly in the central section. The only railroad in South America which entirely crosses the Andes is the one from Valparaiso in Chile to Buenos Aires in Argentina, known as the *Transandine.* Taken as a whole, western South America is highly unfavorable to the building of good roads and railroads, and, as already pointed out, this is one of the serious hindrances to the progress of these countries.

Foreign Trade. — From what has been said it is evident that with the exception of a limited number of products the west coast produces relatively little for export. Minerals, especially nitrate and copper from Chile, tin from Bolivia, and copper and petroleum from Peru constitute the important items. Cacao from Ecuador and sugar and cotton from the irrigated lands of Peru deserve mention.

On the side of imports the trade is relatively small but is increasing (Fig. 315). Moreover the country people, most of whom are Indians or mestizos, live so simply that they require few imported goods (Fig. 303). A large part of the coal, machinery, cloth, shoes, and other manufactured goods now come from the United States, which is also the largest purchaser of the exports.

Cities. — Judged by our standard western South America has no large cities. Each country except Bolivia has ports at which steamships stop. *Guayaquil,* the principal port of Ecuador, has been one of the most unhealthful on the whole coast and was avoided until recent improvements were made. *Quito,* the capital of Ecuador, is situated 9000 feet above the sea and nearly on the equator. Its temperature is said to be that of perpetual spring. The chief city of Peru is *Lima,* one of the oldest cities in the western hemisphere. Bolivia has no city of prominence. *La Paz,* the capital, is at an elevation of 11,000 feet. In northern Chile are several ports from which nitrate is shipped; the largest

are *Iquique* and *Antofagasta.* The chief port of Chile is *Valparaiso,* and the chief city is *Santiago,* the capital, a city of great natural beauty and the largest South American city west of the

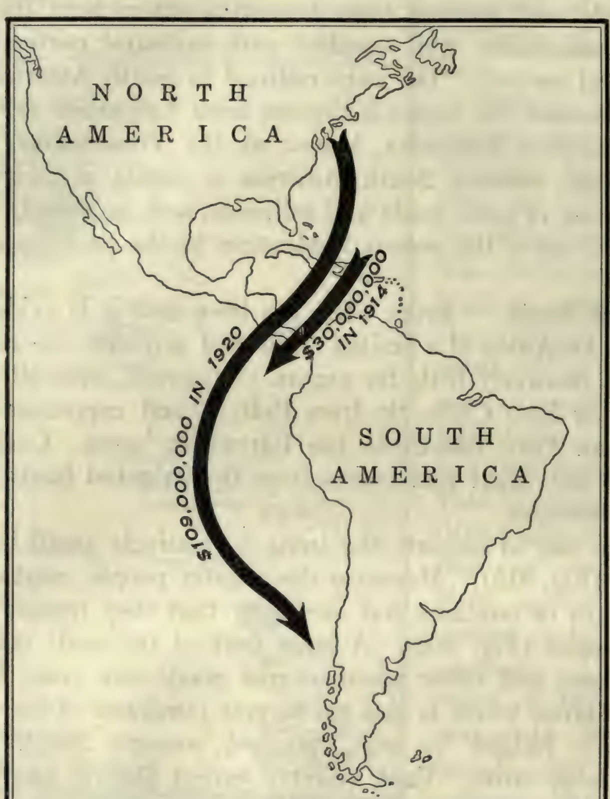


FIG. 315. — Diagram showing the growth of exports from the eastern United States to western South America following the opening of the Panama Canal. A considerable part of the increase was due to higher prices.

Andes. Santiago has a population of somewhat over 400,000, or about that of New Orleans.

ARGENTINA

General Conditions. — By many people Argentina is considered to be the leading country of South America. It lies in the

temperate zone; it is inhabited almost solely by people of European stock; it has extensive areas of excellent agricultural and grazing land, producing a large surplus for export; it has thousands of miles of railroads (23,000 miles in 1921), mainly built with

FIG. 316. — Hauling wheat to the railroad in Argentina. The ponderous carts carry 4 to 8 tons and are drawn by 8 to 10 oxen or horses. (© *Keystone View Co.*)

British capital; it has maintained a stable government for many years, and foreign investments are regarded as safe. There are able men in the country, and the per capita wealth is high. Prior to the World War of 1914–18, Argentina was receiving annually large numbers of European immigrants, especially Italian and Spanish. During the World War and for several years after, conditions were unfavorable, first because of the lack of ships to handle the country's commerce, and later because of financial depression and reduced prices.

Agriculture and Stock Raising. — Argentina has two great industries, agriculture and stock raising. Twenty or thirty years ago stock raising (sheep and cattle) was the more important branch; now agriculture is the more important. The greater part of the country is made up of vast plains called *pampas*, almost as level as the sea (Fig. 316). Many of the farms or estates comprise tens of thousands of acres. In the east, where

the rainfall is most favorable, the plains produce great crops of corn, wheat, flax, oats, and alfalfa; however, droughts are frequent and crop failures are serious. The locusts are terrible pests; they invade the country in clouds and destroy every green

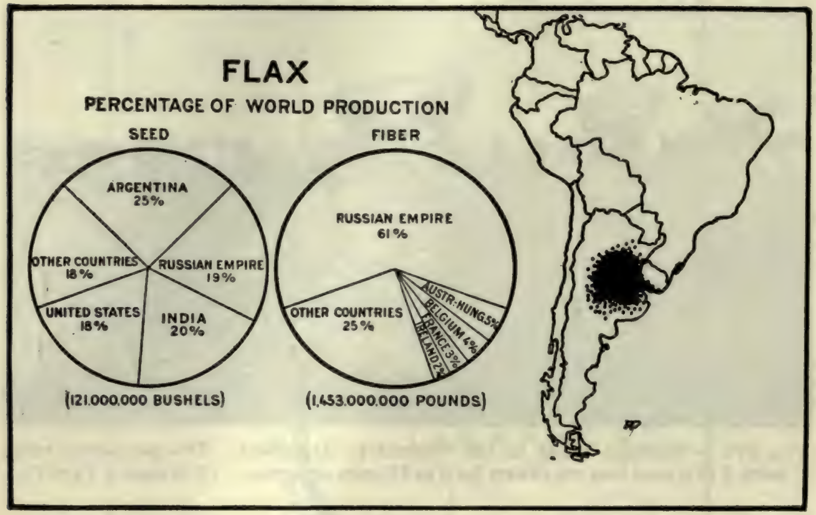


FIG. 317. — The flax-growing region of Argentina. (*U. S. Dept. of Agr.*)

thing in their path. In the year 1917–18 one-third of the wheat, two-thirds of the flax, one-third of the oats, and nearly one-half of the corn were lost on account of locusts and drought. The southern third of the country and a strip near the mountains in the west are too dry for most crops, though suited to sheep raising. More than one-half of Argentina suffers from insufficient rainfall.

Near the base of the Andes, around *Mendoza*, are irrigated vineyards and orchards; in fact, the grape industry there is comparable to that in California. Near *Tucuman*, in the northwest, is an area devoted to sugar cane, making Argentina practically self-sufficient in sugar.

Tens of millions of cattle and sheep and millions of hogs, goats, and horses are raised; and in the semi-arid parts, live stock, and especially sheep, must continue to be the main source of income.

Foreign Trade. — In proportion to population Argentina has a very large foreign trade; in fact, it is one of the leading nations of the world in per capita foreign trade. The country produces so much and the population is still so small (8,000,000) that there is a great surplus of products to sell abroad. This makes it possible also to buy large quantities of imported goods. Unfortunately, the country produces no coal or iron and scarcely any other mineral of importance, therefore it cannot make notable progress in manufacturing; consequently coal and a large proportion of manufactures must be imported. With the great exportation of wheat, corn, hides, skins, meat, wool, and flaxseed, and the large import of mineral products and manufactures, the foreign trade is necessarily large, reaching a billion dollars a year, or more than $100 per capita of the population; this is larger than the normal per capita trade of the United States. We import wool, hides, flaxseed, and varying amounts of other products from Argentina, and sell her coal, petroleum, and all kinds of manufactures.

FIG. 318. — The principal wheat-growing areas of South America. Each dot represents 100,000 bu. (*U. S. Dept. of Agr.*)

Future of Argentina. — The country has excellent prospects because of the temperate climate, large area of level agricultural land, almost exclusively white population, rapidly increasing wealth, and increasingly strong government. It must always be an agricultural and stock raising country because of the absence of minerals; yet the manufacture of dairy products, wines, flour, tanning extracts, meat products, and leather is growing rapidly.

FIG. 319. — Distribution of cattle in Argentina, Uruguay, and Chile.
(*U. S. Dept. of Agr.*)

Uruguay and Paraguay

Uruguay is about the size of California and has a population of 2,000,000, or less than that of Chicago. The people are nearly all whites and the country is prosperous despite prolonged political turmoil. It is a country of only one great industry, stock

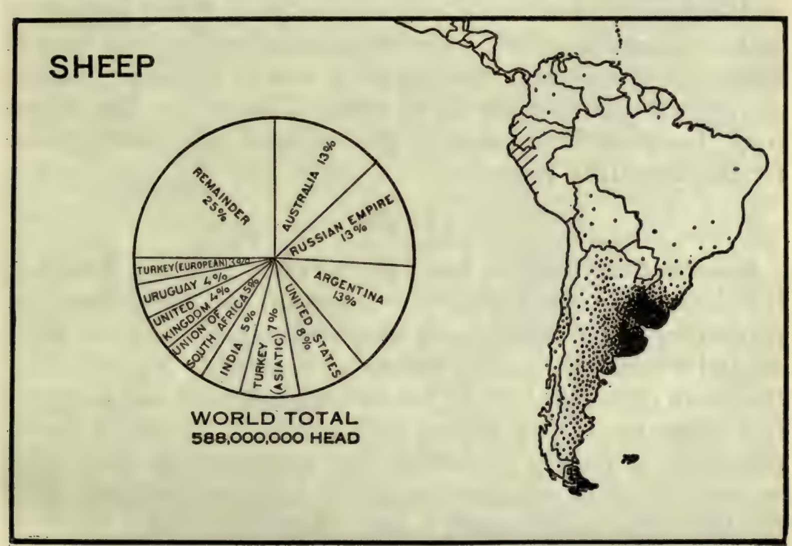


Fig. 320. — Sheep-raising in South America. Each dot represents 200,000 sheep. (*U. S. Dept. of Agr.*)

raising. Nearly all the land is suited to pasturage. The climate is mild and the rainfall fairly abundant (about 35 inches). Sheep and cattle in great numbers graze all the year round (Fig. 320). Large meat packing houses, some of them built by Chicago packers, are located in Uruguay, as well as in Argentina and southern Brazil.

Uruguay has no mineral or forest resources of any consequence, does very little manufacturing, but has, like Argentina, a large foreign trade in proportion to its population. It exports meat, wool, hides, and sheepskins, all products of the live stock indus-

try. The imports are mainly manufactured goods. For a small country Uruguay seems to have a promising future.

Paraguay is quite the opposite of Uruguay. Its people are nearly all Indians; a large part of the country is jungle; neither farming nor stock raising is carried on beyond supplying the simple needs of the simple people. One crop of importance is grown and exported, *yerba maté,* or Paraguay tea. When steeped, it makes a pleasant, mildly stimulating drink, said to have no bad effects upon the user. Oranges grow wild in Paraguay and are so common that they are fed to hogs. The country has no seacoast, has made little progress, and seems to have little promise for the immediate future.

Brazil

General Conditions. — Brazil is the giant of South America; it is larger than the United States proper, has three times the population of any other South American country, and has great natural wealth and a great variety of resources. About half of the country is tropical jungle, but an area in the east and southeast four times the size of France or Germany is capable of developing into a densely populated and progressive section. This section is hilly or mountainous, but the altitude helps to offset the high temperature which would otherwise prevail.

The Amazon Forests. — These are among the most impenetrable jungles known, and they can scarcely be traversed except along the river courses. The most valuable trees here are the rubber trees, found far up the rivers in Bolivia, Peru, and Colombia, as well as in Brazil. Until a short time ago when the output of plantation rubber in southeastern Asia became so large, Brazil was the world's chief source of rubber. It is still the chief producer of the wild product, but the Amazon basin now provides only a small fraction of the world's total supply of rubber.

Coffee.[1] — Brazil has become the world's chief source of coffee, producing from 70 to 75 per cent of all that is used (Fig. 321).

[1] Some member of the class should make a special report on the coffee industry of Brazil.

The coffee tree thrives only in the tropics and grows best on uplands where the soil contains quite a good deal of iron. The red

Fig. 321. — Coffee tree loaded with ripe coffee berries. Brazil produces about 73 per cent of the world's coffee. (© *Keystone View Co.*)

soil of Brazil, the low mountains not far from the sea, the tropical sunshine, and ample rainfall in this region combine to make

southeastern Brazil the paradise of the coffee grower. For the most part the coffee is raised on plantations of large extent having thousands and even millions of trees each; one has over 20,000,000 trees. Such plantations require a large investment of capital and hundreds of laborers. The coffee trees are allowed to grow to a height of ten or twelve feet; the coffee berry resembles a red cherry, within which are two coffee beans. The red pulp is removed and the kernels are carefully cured in the sun; the coffee is then bagged and sent to the shipping ports, especially to Santos, the greatest coffee port in the world (Fig. 323). Rio de Janeiro is also an important shipping port. Coffee is the all-important crop of Brazil; few countries are so dependent upon a single crop as Brazil is upon coffee. The value of the crop in recent years has reached $150,000,000 a year. Most of it is raised in a compact area back of Rio de Janeiro and Santos (Fig. 322).

Other Productions. — Brazil is one of the largest producers of cacao beans, from which chocolate is made. Along the coast lands cotton, sugar, rice, and tobacco are raised in increasing quantities. Southern Brazil raises millions of cattle on its extensive areas of pasture land. Modern packing plants have been established, mainly by American packers, and southern Brazil, along with Uruguay and northern Argentina, is becoming one of the important sources of meat for Europe, and possibly in the future for the United States.

Mineral Wealth. — Brazil has some of the most valuable iron ore deposits in the world. Unfortunately, there is no native coal with which to smelt the ore, which is located somewhat over 400 miles inland. Brazil is one of the three principal sources of manganese, a metal which is essential in the making of steel. At one time there were valuable gold mines and diamond mines in this part of Brazil, but the gold is practically all worked out, and the diamonds, chiefly of the black variety, are found only in limited numbers. Though there is considerable known mineral wealth, and doubtless much that is undiscovered, the present mineral industries of Brazil are not of great importance.

Transportation. — Like all other South American countries

Brazil has few good roads. In the Amazon basin the rivers form the routes of transportation, especially for bringing out the rubber and for distributing supplies to the rubber gatherers, who are mostly Indians. Far up the Madeira River near the boundary

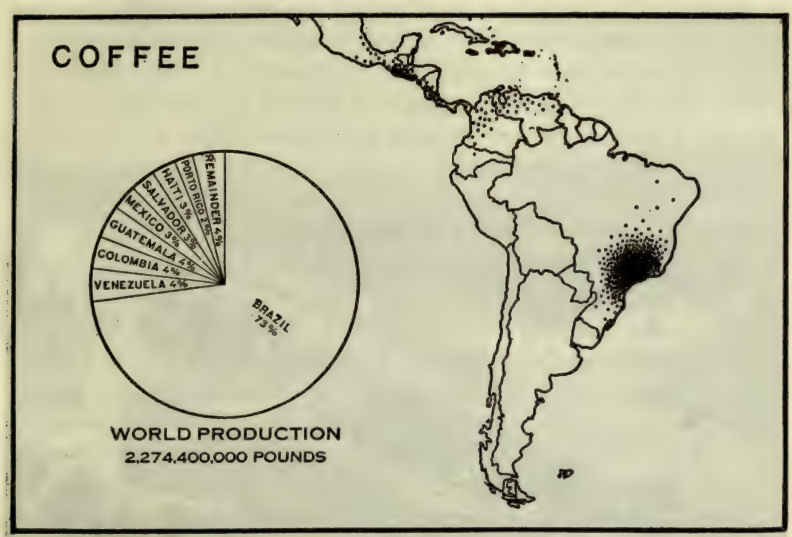


FIG. 322. — The coffee-growing regions of Central and South America. Each dot represents 5,000,000 pounds. (*U. S. Dept. of Agr.*)

of Bolivia is a railroad around the rapids 200 miles long. This railroad and river form an important route into and out of Bolivia. The coffee district has a network of railroads, and many short lines extend inland from various ports. There is continuous rail connection between Rio de Janeiro and Montevideo and Buenos Aires. Brazil has somewhat less than 20,000 miles of railroad, Argentina nearly 25,000 miles, and the United States over 260,000 miles.

Manufactures. — Nowhere in South America has manufacturing become really important. Brazil has made a good deal of progress in the making of cottons, shoes, hats, tobacco, flour, meat products, and some other things; but native coal is poor,

and inadequate in amount, and imported coal is expensive. Of the great amount of water power in this country only a little has been developed. Capital and competent labor for extensive manufacturing are not available within the country.

FIG. 323. — View of Santos, Brazil, the leading coffee-exporting port of the world. (*Pub. Photo. Service.*)

Foreign Trade. — Among South American countries Brazil has a total foreign trade second only to that of Argentina, and about one-tenth that of the United States. Of the total export trade, about one-half is coffee and one-tenth is rubber. The people of the United States are the greatest consumers of coffee and they purchase more than half of all that Brazil exports. So heavy are our purchases of coffee that the value of our exports to Brazil falls much below that of our imports from that country. During

the World War and since, Brazil has bought the larger part of her imports from the United States. The peculiar character of the foreign trade of Brazil may be seen in the fact that nearly 50 per cent of the imports are manufactured goods and about 80 per cent of the exports are agricultural products.

Cities of Eastern South America. — *Buenos Aires,* the capital and chief port of Argentina, is the largest city in the southern hemisphere and the largest Spanish-speaking city in the world. It has had a most remarkable growth and is nearing a population of 2,000,000. More than one-fifth of the people of Argentina live in this single city. On the map (Fig. 308) note the location of *Rosario, Bahía Blanca,* and *La Plata,* which are important shipping ports. *Montevideo,* across the estuary of the Plata from Buenos Aires, is the capital and chief port of Uruguay and is a thoroughly modern, progressive city. *Rio de Janeiro,* the capital of Brazil, is situated on one of the finest harbors in the world. Its water front has been improved at great expense and from the bay presents an appearance of unusual beauty. The city has a population of over 1,000,000. *Santos,* the great coffee-shipping port (Fig. 323), *São Paulo* in the coffee district, *Para,* the rubber-shipping port at the mouth of the Amazon, *Manaos,* the chief rubber-collecting center up the Amazon, *Bahía,* and *Pernambuco* are all cities of more or less importance. Locate them on the map (Fig. 308).

Relations of the United States to South American Countries

The United States and the South American countries ought to maintain close and friendly relations. The tropics produce things which we need in ever increasing quantities; we also need the wool, hides, and flax of Argentina, the nitrates of Chile, and the tin of Bolivia. Some of the largest mining operations in the Andes are financed and controlled by Americans. Moreover, South America depends upon outside countries for most of its coal, petroleum, machinery, and manufactures of all kinds. These we can supply and ought to supply as we are now doing.

Many American banks have already been established in Latin America; we have more ships under the American flag prepared to serve our trade than we ever had before, and a cordial feeling exists between the United States and most South American countries.

The Latin Americans and the Anglo-Americans are different in their ways of doing and thinking; they speak different languages and have different traditions and customs. The Latin Americans of education and refinement are often offended by the aggressiveness and informality of North Americans. Our hustling ways sometimes grate upon their sensibilities and they resent the attitude of superiority which a certain type of American assumes. On our side we are likely to be annoyed at the easy-going, procrastinating ways of the Latin Americans. Yet these differences in point of view can be overcome by a display of genuine good will. There is still some suspicion of our intentions, for some Latin Americans fear that our Monroe Doctrine is only an excuse for gaining an increasing political control in Latin America. It is of utmost importance that the United States demonstrate in every possible way its sincere desire to help its sister republics for their own benefit first of all; that we convince them by all our actions that we do not desire their territory or desire to gain any political control over them.

During the World War, nearly all of the South American countries arrayed themselves on the side of the Allies. As a result of the cutting off of trade with Germany and of the necessary decline in trade with Great Britain our trade with South America grew notably.

EXERCISE XXVI

1. Why are there no large rivers on the Pacific slope of South America?
2. Why is only a small proportion of Mexico suited to agriculture?
3. Why is a country like Mexico likely to have greater mineral wealth than one like Argentina?
4. Why is the position of Mexico better for commerce than that of Chile?
5. Why are the forests of Central America heaviest on the eastern side?
6. Why are most of the important cities of Central America and western South America inland instead of on the coast?

7. Why is agriculture more important in Argentina than in Chile? Why more important in Chile than in Bolivia?

8. Why is the rubber industry of Brazil declining in relative importance?

9. Why has railroad development in Argentina been more rapid than elsewhere in South America?

10. Why is Argentina not likely to become a manufacturing nation?

11. Why is the rainfall of the Amazon Valley very heavy? Why light in most of Argentina? Why heavy in southern Chile?

12. Why is southern Argentina (Patagonia) better suited to grazing than to agriculture? Why better suited to sheep than to cattle?

13. Why is water transportation employed more in the Amazon Valley than in the Mississippi Valley?

14. Why is eastern Peru a jungle and western Peru a desert?

15. Why is the large size of Brazil less an advantage than it might seem?

16. Why is southeastern Brazil the most promising part of that country?

17. Why is South America more likely to be an importer than a maker of manufactured goods?

18. Why must ore deposits in the Andean countries be exceptionally rich in order to be worked at a profit?

19. Why are the Andean countries seriously handicapped in their development?

20. Why do foreign investors hesitate to invest their capital in several of the Latin American countries?

21. Why did the United States build the Panama Canal?

22. Why is Cuba exceptionally prosperous?

23. Why is banana growing more profitable in the Caribbean region than in tropical Africa?

24. Why are there few large cities in South America?

CHAPTER XXII

THE BRITISH EMPIRE

Extent. — The British Empire is the largest in the world; in both area and population it is four times the size of the United States. British India is the most populous dependency, while both Canada and Australia are as large as the United States; but together they have a population not much greater than that of New York State. Great Britain now controls territory from one end of Africa to the other (Fig. 324). A surprisingly large number of the most valuable points on the great ocean routes of trade are British; these include Gibraltar, which commands the narrow entrance to the Mediterranean Sea; Malta, near the center of the Mediterranean Sea; the Suez Canal, still the most important ship canal in the world; Aden, which commands the southern entrance to the Red Sea; Ceylon, midway across the Indian Ocean; Singapore, which commands the narrow strait of Malakka; and Hong Kong, off the coast of China — a continuous chain along the most important trade route from the Atlantic to the Far East. In Central America is British Honduras, a small tropical colony. In the West Indies are Jamaica, Barbados, Trinidad, and other islands; and in the northern part of South America is British Guiana. The Bahamas, east of Florida, and the Bermudas farther north are also British. These possessions give Great Britain a strong position in the middle Atlantic and in the Caribbean Sea. Besides these colonies there are, in every sea, islands and groups of islands which belong to Great Britain; no other empire of such extent has ever existed. The widely scattered possessions give an opportunity for coaling stations and naval stations in every part of the world, and these, together with the powerful British navy, give Great Brit-

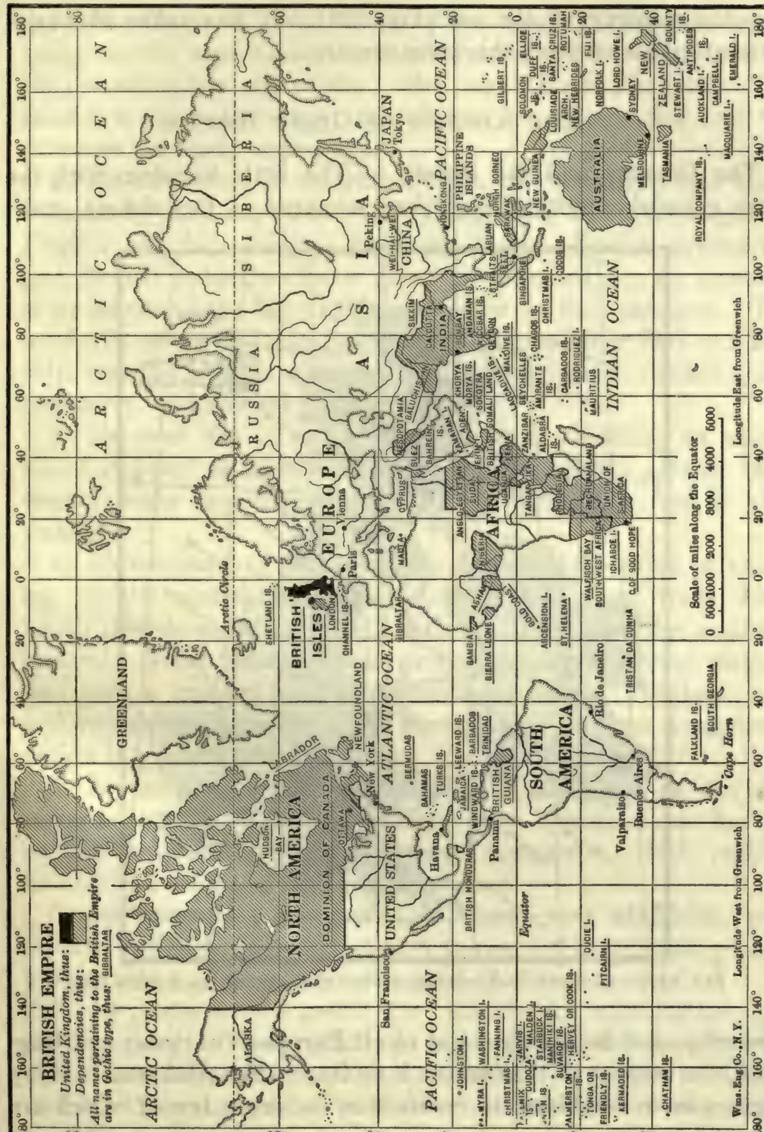


FIG. 324. — The British Empire.

ain the mastery of the sea (Fig. 324). It has taken centuries to acquire and cement this great empire.

The Kingdom of Great Britain

The Country and the People. — The little kingdom with the vast colonial empire that it has acquired is the richest, most

Fig. 325. — Rainfall and prevailing wind direction of the British Isles.

powerful, and most influential of all European nations; yet England, the nucleus of the empire, is no larger than Alabama. Many factors have combined to create this nation, a few of which are referred to here:

1. *Its climate* is mild, much milder than its latitude would cause one to expect, due to the influence of the ocean and to the prevailing westerly winds. (See page 306 and Fig. 325.) The rainfall is ample for crops; the winters are invigorating and the summers are rarely oppressive.

2. *Its insularity,* or separation from the continent, has made invasion by land impossible. No foreign war has been fought on English soil for nearly a thousand years. British agriculture and British industries have never been ruined by an invading army as they have been again and again on the continent. The insularity of the nation has favored shipbuilding and seamanship, and has given it a strong bent toward the sea, toward ocean commerce, and toward colonization.

3. *Its coast line* is remarkably indented, affording an exceptional number of harbors, mostly at river mouths. More than twenty ports have a depth of at least twenty-five feet at high water.

4. *Its resources of coal and iron* have greatly aided in building up the manufacturing industries and overseas trade, from which British wealth is largely derived. Without these essential minerals, Great Britain would probably have remained what it was over a century ago, an agricultural nation. Without coal and iron or easy access to them, a great industrial and commercial nation is scarcely possible.

5. *Its position,* at the front door of Europe and on the side toward America, is a commanding one. France alone has an equally favorable position for ocean commerce. Both nations lie near the center of the land hemisphere.

6. *Its government* is remarkably liberal and adaptable, conservative enough and rigid enough to prevent hasty changes, yet always able to change when the need of change is clear.

7. *Its people* have a genius for business, for colonization, and for diplomacy. The Englishman never knows when he is beaten and, as a consequence, he has won almost every great conflict in which he has engaged. The stubbornness and persistence of the British are proverbial.

Thus does Britain combine in its people, its country, and its climate a remarkable group of advantages out of which the powerful nation has developed.

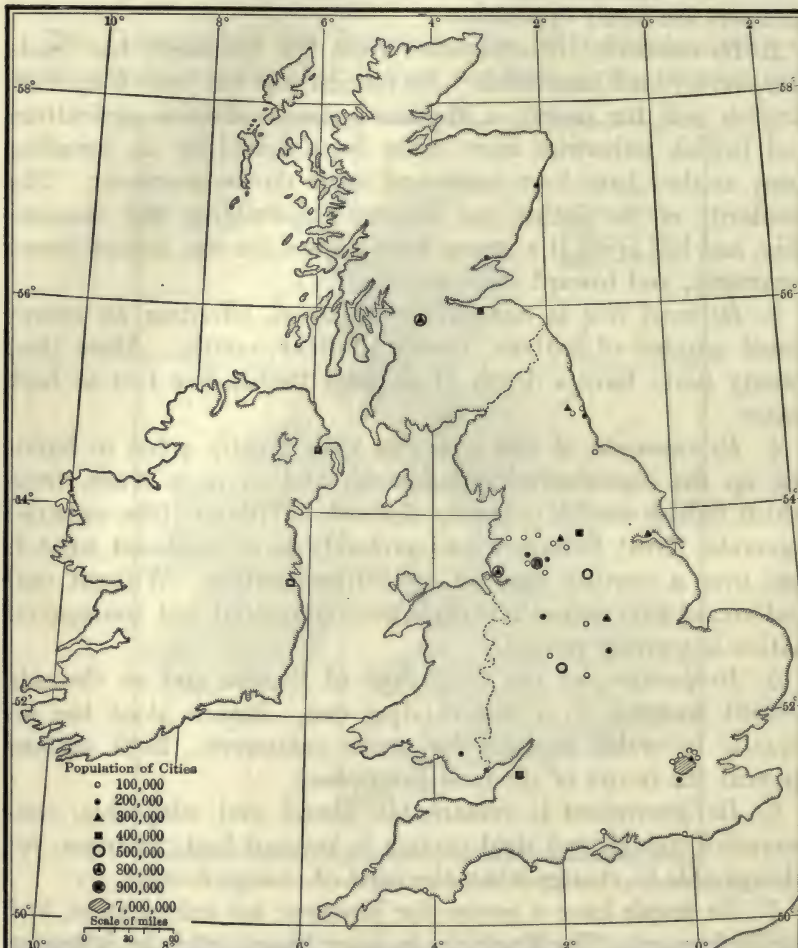


FIG. 326. Location of the Chief Cities of the British Isles.

The Status of Ireland. — Early in 1922, Ireland, which had

FIG. 327. — Coal in Great Britain. 1, Clackmannan; 2, Fifeshire; 3, Clyde; 4, Lothians; 5, Ayrshire; 6, Lesmaha Co.; 7, Straiton; 8, Northumberland and Durham; 8a, Cumberland; 9, Ingleton; 10, Lancashire; 11, Yorkshire; 12, Derbyshire; 13, Flintshire; 14, Denbighshire; 14a, Anglesey; 15, North Staffordshire; 15a, Shropshire; 16, South Staffordshire; 17, Warwickshire; 17a, Leicestershire; 18, South Wales; 18a, Pembrokeshire; 19, Forest of Dean; 20, Bristol. (*Geog. Rev.*)

long been dissatisfied with her relations to Great Britain, secured recognition as "The Free State of Ireland," remaining within the British Empire but being wholly self-governing. The northern part, known as Ulster, has its own parliament, separate from the rest of Ireland.

Resources. — *Minerals.* England, Scotland, and Wales all have large deposits of coal, and the combined output is second only to that of the United States (Fig. 326). Several of the coal areas are close to the sea (Fig. 328), making the shipment of coal by water very easy. The coal of South Wales goes to most of the countries within 5000 miles that need to import coal. The British Empire is estimated to have one-fourth of the coal of the world. Eighty per cent of the value of all minerals mined in Great Britain is in coal. The iron mines have been among the largest producers in Europe, but now they supply less than half the country's needs. The famous tin mines of Cornwall have been worked for upwards of two thousand years, but are nearly exhausted. With the exception of clays and building stones no other minerals are produced in important quantities.

The *fisheries* yield the only food product that the islands have in surplus. The rather shallow waters which surround the British Isles give rise to the most important sea fisheries in the world. This is especially true of the North Sea. The British fishing fleets constitute the training school for British seamen and have had no small part in making Great Britain the foremost maritime power among the nations.

Soil. — Products of the soil have fallen to a secondary position. About one-fourth of the land of the British Isles is arable; this is mainly in England and Ireland; the latter country being mainly devoted to agriculture. Nowhere in Europe is the raising of high-grade cattle and sheep so important as in the British Isles, where more sheep are raised than in Germany, Holland, Belgium, and France combined (Fig. 328). Farming on the high-priced land of Great Britain has almost ceased to be profitable, and before the World War it had declined greatly; so dependent is Great Britain upon imported food that the nation would starve in three

months if outside supplies were cut off. Such crops as are grown are those of the cool temperate zone, including wheat and other cereals, potatoes, root crops, and hay; 40 per cent of the farm land is used for pasturage. Cultivation is much more intensive than in the United States and the yield per acre is much higher.

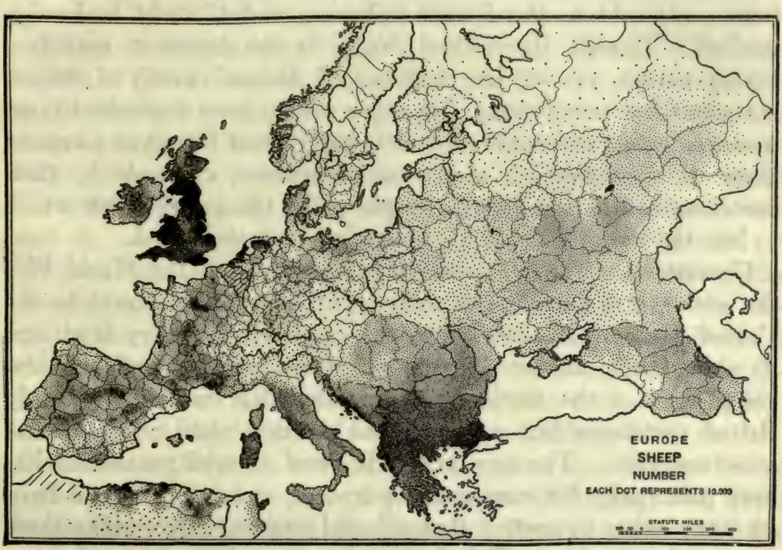


FIG. 328. — Distribution of sheep in Europe. (*U. S. Dept. of Agr.*)

Industries. — Five times as many people in Great Britain are engaged in mining and manufacturing as in agriculture. Manufacturing is especially concentrated on the coal fields (Fig. 327). Of the many lines of manufacturing, iron and steel products (including ships) rank first. The manufacture of textiles, cotton first and woolen second, is the other great industry. The raw cotton is all imported (most largely from the United States), and its manufacture is centered around Manchester in the northwest of England. Britain was long the greatest exporter of cotton goods and the greatest builder of ships in the world. Besides the vast quantities of cotton, woolen, and linen goods, and the endless variety of metal products, British mills

and factories manufacture almost everything else that people use. Most of the raw materials must be imported. In manufacturing these raw materials into finished products, millions of working people are employed and billions of dollars of British capital are invested. The manufactured goods are (1) used at home; (2) sold to the British colonies; and (3) sold to foreign nations. Though the United States is the foremost manufacturing nation, yet we buy millions of dollars' worth of British manufactures every year. No other nation is so dependent upon manufacturing and commerce as is the United Kingdom; around these the economic life of the nation centers, and only by their continuance can the British people make the money with which to buy the imported food and materials that they need.

Commerce. — The United Kingdom was until the World War the greatest of commercial nations; it now ranks second to the United States. Its merchants buy and sell in every land and its ships reach almost every port. Over one-third of the seagoing ships of the world fly the British flag, carrying not only British commerce but much of that of the United States and of other countries. The constant addition of colonial possessions has been principally for commercial purposes, and the powerful British navy exists to protect that colonial empire. By owning these many colonies, Great Britain is more sure of securing the raw materials that her manufacturers require, and also is more sure of markets in which to sell her manufactures. It is said that "Trade follows the flag." All nations may sell goods to British colonies, but many of these colonies charge a lower tariff on British goods than on foreign goods; this is true in Canada and in the British West Indies; yet, partly because of nearness, the United States sells more of its products in these colonies than does the mother country.

Besides buying raw materials and selling manufactured goods, the British carry on a very large trade in other products, such as wool, rubber, furs, metals, etc., which are produced in the more remote parts of the world, brought to England, and reshipped to countries that need them. For example, the United States

buys considerable wool, rubber, tin, jute, and many other articles through London.

British imports exceed exports by hundreds of millions of dollars annually. Formerly this unfavorable balance of trade was offset by the income from British investments in foreign countries and by the large earnings of British ships.

Cities. — *London,* on the Thames, is the political and financial capital of the empire, the largest city, and greatest center of trade in the empire; it was the world's greatest port for 200 years and may be again when the bad effects of the World War are more fully corrected. Greater London has a population of about 7,500,000. *Liverpool,* on the west coast, is the second commercial city of the kingdom and the first in trade with America; it is connected by ship canal with *Manchester,* the center of the greatest cotton manufacturing district in the world and "the natural focus of fully 8,000,000 people." The city of *Oldham* in this district has between twelve and fifteen million cotton spindles. *Glasgow* on the Clyde in Scotland, *Newcastle* on the Tyne, and *Belfast* in the north of Ireland are great shipbuilding centers. *Birmingham, Sheffield,* and surrounding cities are iron and steel centers. *Dublin* is the seat of government of Ireland, and *Edinburgh* of Scotland. *Hull, Southampton, Bristol,* and *Cardiff* are other important ports. Locate each of these cities (Figs. 325, 348).

Summary

1. The commercial and industrial greatness of the United Kingdom arises largely from four factors:

A. The advantageous situation of the islands at the front door of Europe and on the side nearest America. To its situation is due also the mild but invigorating climate without which the British character and energy might not have developed.

B. Great Britain's insularity makes land invasion impossible; it has saved British industries from the ruin of war, which has so often prostrated parts of the continent; it has encouraged the sea fisheries, the building and operation of ships, and the development of ocean commerce.

C. The great coal resources have supplied most of the power which drives British machinery and British ships and so have made possible the enormous growth of manufacturing and commerce which supports the nation.

D. The characteristics of the British people, and the strong, liberal government which they have evolved, comprise the most potent factor of all, yet these are doubtless the outgrowth of still more fundamental causes.

2. Great Britain's most notable achievements are in the realm of (*a*) manufacturing, (*b*) commerce, (*c*) colonization, and (*d*) empire building. In the latter two, the country has no equal, and her only equal in the former two is her offspring, the United States.

3. The British Empire is the most extensive and populous that ever existed, and includes parts of every continent, islands in every sea, and the most strategic points in the world's great trade routes. To serve and to defend this widely scattered empire the British merchant fleet and the British navy have been made the largest in the world.

4. Within the United Kingdom agriculture declined in importance during the past century. The raising of superior cattle and sheep is a prominent industry; the fisheries are highly important and supply the only item of food that the nation produces in surplus. Coal forms 80 per cent of the value of all the minerals produced; iron is a distant second in value. Iron and steel products and cotton, woolen, and linen goods are the great lines of manufacturing. There are over 20 excellent harbors. Shipbuilding and the operation of ships in the commerce of all nations are leading industries. London was for 200 years the world's greatest port, a position which was lost to New York during the World War and which may or may not be regained.

Canada

Government and People. — For more than 200 years Canada was New France, a part of the great colonial empire which the French kings ruled in America. Defeated by the English at Quebec, France had to give up this vast domain and it became


POLITICAL MAP OF
THE DOMINION OF CANADA
NEWFOUNDLAND
AND GREENLAND
Scale of statute miles
0 100 200 300 400 500
GREENLAND
(To Denmark)
BAFFIN BAY
DAVIS STRAIT
ARCTIC OCEAN
ATLANTIC OCEAN
PACIFIC OCEAN
NORTHWEST TERRITORIES
YUKON
BRITISH COLUMBIA
ALBERTA
SASKATCHEWAN
MANITOBA
ONTARIO
QUEBEC
LABRADOR PENINSULA
NEWFOUNDLAND
NOVA SCOTIA
NEW BRUNSWICK
HUDSON BAY
Hudson Strait
UNITED STATES
Gulf of Alaska
Longitude West from Greenwich
Williams Eng. Co., N.Y.

FIG. 329

a British dependency in 1763. A century later (1867) the various parts (except Newfoundland) were merged into the Dominion of Canada with its capital at Ottawa. The people of Canada have self-government in all except foreign affairs. The Domin-

FIG. 330. — A logging scene in Canada. (*Physiography Lab. Cornell Univ.*)

ion is larger than the United States; it is composed of ten provinces and the Northwest Territories (Fig. 329); the provinces correspond to our states, but average much larger in size: Quebec, for example, is three times the size of Texas.

The population (about 9,000,000, or less than that of New York State) is very small for so large a country. A majority of the people in the province of Quebec are French Canadians, speaking French and constituting a rather distinct people. About one-third of the total population of Canada live in the southern part of the province of Ontario.

The Vast Areas of Waste Land. — Canada is a northern land; nearly two-thirds of the country is north of the 55th parallel, and most of this is ill-suited to agriculture. The Labrador peninsula is barely explored; British Columbia is mountainous, and large

FIG. 331. — Interior of a wood-pulp mill, Ottawa, Canada. The United States is becoming increasingly dependent upon Canada for paper pulp. (© *Keystone View Co.*)

parts of Ontario and Quebec are covered with forest, swamps, lakes, or bare rock. About one-twentieth of the total land of Canada is occupied, and one-fiftieth is under cultivation. This is partly due to the slow growth of population and partly to unfavorable natural conditions, especially climate. A great deal

of good land, however, is still unoccupied; and, considering Scotland and Scandinavia, with their northern climate and scanty soil, the Canadian's faith in the future of his vastly larger and richer country is entirely justified.

Forest Wealth and Industries. — Canada's forests are one of her great natural resources; about 22 per cent of the total area

FIG. 332. — Regions of chief mineral production in Canada. Each circle represents a value of $1,000,000 in 1919, a year of active production.

is forested. While this is nearly as large as the forested area of the United States, it has less merchantable timber (Fig. 330). The forests are mainly evergreens, such as pine, spruce, and fir, though hardwoods are included. The timber most easily reached has been cut, and forest fires still cause enormous losses, as they do in the United States. Canada's forest products amount to about $300,000,000 a year, about one-fifth of those of the United States. Our own supplies of sprucewood for paper pulp are badly depleted and we are already drawing heavily upon Canada (Fig. 331).

Fisheries. — The shallow waters off the east coast of Canada near Newfoundland and Nova Scotia are among the most important fishing waters of the world, yielding lobsters, cod, herring, halibut, mackerel, etc., while British Columbia yields upwards of

$150,000,000 pounds of salmon a year. The total value of the fish, about $35,000,000 a year, is far below that of minerals, forest products, or farm crops, yet the fisheries employ 90,000 to 100,000 men, and give Canada a place among the leading fishing and fish-exporting nations of the world.

Canada's Mineral Resources. — Canada is a large country and it is probable that only a fraction of its mineral wealth has yet been discovered. The minerals of greatest importance to any nation are coal, iron, copper, and petroleum.

Coal. — Canada has coal of good quality in Nova Scotia and Cape Breton Island. From these mines comes half the coal mined in Canada (Fig. 332). The seaboard provinces and Quebec use most of it, but a few hundred thousand tons are shipped to New England ports. In the whole long stretch between Nova Scotia and Saskatchewan, a distance of nearly 2000 miles, there are no coal beds. This would be a serious handicap if coal could not be secured from the United States. The coal of Saskatchewan is of low grade and can be used only near the place of mining. Alberta has a large area of fair coal and British Columbia has several deposits of good quality. The great drawback is the absence of coal in the province of Ontario, which is the most populous and needs it most and yet has to import it from the United States.

Iron. — The greatest iron mines in the world are in Minnesota south of the Canadian boundary; but in all of the Dominion of Canada almost no iron is mined and no important deposits are known. Newfoundland has mines which supply steel plants in Nova Scotia and Cape Breton and export a little. Canada's shortage of this most important of metals is unfortunate, especially since manufacturing is developing rapidly in parts of the Dominion.

Other minerals (Fig. 332). — The richest nickel mines in the world, producing over half the world's supply, are at Sudbury in Ontario. Not far away are the rich gold and silver mines of the Cobalt district. Copper, lead, and a long list of minor minerals are mined. Thus far, no petroleum of importance is produced. At present Ontario yields about 40 per cent, British Columbia

25 per cent, and Nova Scotia 15 per cent (in value) of the minerals produced in Canada. The total mineral output is still relatively small, but it will increase greatly as population and development go on increasing.

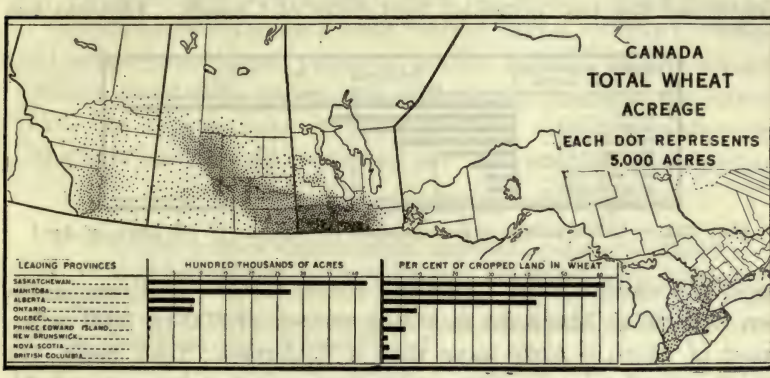


FIG. 333. — The wheat-raising areas of Canada. (*U. S. Dept. of Agr.*)

Water Power. — Canada has enormous water power possibilities. Ontario and Quebec alone are officially estimated to possess 12,000,000 horse power, or about 8 times the amount that may be developed at Niagara Falls on both sides of the river. The glaciation of Canada produced almost countless rapids and lakes; the latter form natural reservoirs for the storage of water, while the rapids and falls give the necessary drop to create power. The shortage of coal in these provinces may be partially offset by developing the abundant water power.

Agriculture. — This is the greatest of Canadian industries. The amount of land at present under crops in the Dominion is somewhat greater than that in Illinois and Iowa, but several times this amount will probably prove to be suited to agriculture, and this will exceed the agricultural area of any European country except Russia. The little province of Prince Edwards Island is nearly all cultivated or used for pasturage, but the greater part of Nova Scotia and New Brunswick is unsuited to agriculture. Scarcely 2 per cent of the great province of Quebec produces farm crops.

The part of southern Ontario lying near Lakes Huron, Erie, and Ontario is the garden spot of eastern Canada. This region is as productive as the states of Michigan and New York, between which it lies. This peninsula and the Annapolis Valley of Nova Scotia are the two principal fruit belts of Canada. Ontario has

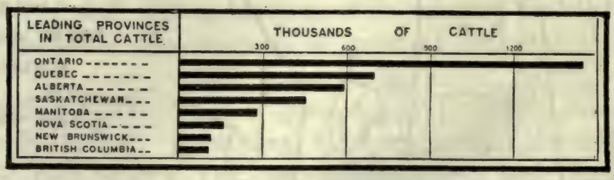


FIG. 334. — Cattle raising in the Canadian provinces. (*U. S. Dept. of Agr.*)

most of Canada's dairy farms and cheese factories. From southern Ontario to Manitoba is a long stretch of 800 to 1000 miles, most of which is little more than a wilderness; then begin the rich prairie lands of southern Manitoba, Saskatchewan, and Alberta. These cereal lands have developed rapidly during the past 30 years and are becoming one of the great wheat-producing areas of the world (Fig. 333). These three provinces are yielding nearly 300,000,000 bushels of wheat and about 400,000,000 bushels of oats yearly, in addition to many lesser crops. Fruit farms and other farms occupy some of the valleys of British Columbia, but the product is small. The total value of farm products of Canada is about one-tenth that of the United States.

Manufactures. — Not only is Canada a relatively undeveloped country, but it mines very little iron, has no coal in its most important province, and has a small population. All of these conditions retard the growth of manufacturing. In 1920 the Dominion employed a half million people in its mills and factories and turned out $1,500,000,000 worth of products. This was somewhat below the figures for New York City alone. The output was greatly increased during the progress of the World War but dropped back somewhat afterward.

Foreign Commerce. — In proportion to population Canada has an exceptionally large foreign trade. Before the World War,

imports exceeded exports, but this was reversed during the war. At present the two nearly balance. Canada buys over half her imports from the United States, because of nearness and the use of a common language. Our trade with Canada is larger than that with any other country except the United Kingdom. More than half of Canada's exports come to the United States. Why? Wheat and other agricultural products are by far the leading exports. Lumber, wood pulp, paper, and other forest products are second. While her imports have in the past-been mainly manufactures, Canada is increasingly supplying her own needs in this direction.

EXERCISE XXVII

1. Why is so much of Canada either unsettled or sparsely settled?
2. Why is Labrador so much colder than the British Isles, which are in the same latitude?
3. Why do the forests of Canada contain less merchantable timber, acre for acre, than those of the United States?
4. Why are ocean fisheries regarded with special favor by most governments?
5. Why are Canada's mineral resources less explored and less developed than those of the United States?
6. Why is Canada both fortunate and unfortunate in her coal resources?
7. Why is the shortage of iron ore in Canada a matter of importance?
8. Why is the great water power of Canada of special value to the country?
9. Why was manufacturing slow to develop in Canada?
10. Why does Canada buy more from the United States than the United States buys from Canada?
11. Why does Great Britain buy more of Canada's products than any other European country buys?
12. Why is it to be expected that a country like Canada will have a larger per capita foreign trade than a country like the United States?

BRITISH POSSESSIONS IN ASIA

The Indian Empire

The People. — Of all the possessions of Great Britain, India is the most important. It is nearly two-thirds the size of the United States and has over 300,000,000 people — about 65 per cent of the entire population of the British Empire. When England took possession of India it was made up of many native states,

each under its own ruler. So diverse is India that each one of eleven different languages is spoken by more people than speak English in India. Newspapers are issued in more than twenty-five languages. Seven different religions in India count their followers by millions. The vast majority of the people are very poor and illiterate, yet they are better off than before they came under British rule. The average earnings of a laborer are from $10 to $20 a year. Famines, carrying off millions of people, have been frequent, but are diminishing. The caste system is practically universal; there are four principal castes, but these are divided and subdivided until more than 2000 castes and sub-castes are officially recognized.

The Climate. — The cause of the monsoon winds, which in summer blow from the sea over India and in the winter blow from the land, is discussed on page 270.[1] The summer or wet monsoon is all-important to India; if it fails to bring the accustomed rainfall, millions of people suffer and thousands starve. Most of India is in the torrid zone or just north of it, and is very hot and sultry in summer. In the tropical part children of European parents cannot as a rule be reared in health; hence few English families live continuously in tropical India. The rainfall is terrific on the slopes of the Himalayas in northeastern India; but northwestern India, the plain of the lower Indus, is mainly desert. In almost all parts of India irrigation is practiced during the dry (or winter) season. Nowhere else in the world is irrigation so extensively employed. One of the greatest benefits to agriculture in India is the great irrigation works constructed by the British.

The Importance of Agriculture. — The all-important industry of India is agriculture, practiced by 80 per cent or more of the people, who live in little villages and work little pieces of land by antiquated methods. Almost everything is done by hand or possibly with the aid of a cow or bullock. Over half of the land is under cultivation, for most of the food for 300,000,000 people

[1] Review the section on the Monsoons in Chapter XIV, page 270, and that on the Ganges in Chapter IX, page 178.

Fig. 335. — Pilgrims bathing in the sacred Ganges, before the many temples of the holy city of Benares. (© *Keystone View Co.*)

must be raised at home. The growing of rice on from 60 to 70 million acres surpasses everything else (Fig. 336). Wheat comes next, followed by cotton; both are exported to quite an extent. India ranks second to the United States as a grower of cotton.

Fig. 336. — Note the concentration of rice production in the valley of the lower Ganges and Brahmaputra rivers. (*U. S. Dept. of Agr.*)

Great quantities of millet are raised for home use. Next to Cuba, India is the largest producer of cane sugar in the world, but it is mostly used at home. India also has more cattle than any other country, though for religious reasons they are not widely used for meat. The lowlands at the mouth of the Ganges produce

three-fourths of the jute grown in the world. Jute is a fiber used by the millions of bales in making coarse bags (gunny sacks) used for shipping raw sugar, coffee, grain, cotton, and many other commodities; it is also used for making burlap and cordage. The tea

FIG. 337. — Railroad station, Bombay, India. (*Courtesy Nat. City Bank.*)

plantations of India and Ceylon together export nearly twice as much tea as China and Japan combined.

The Backward State of Mining and Manufacturing. — India has moderate resources of coal, iron, gold, petroleum, manganese, and a number of other minerals, but the total output of minerals is only about $100,000,000 a year, or less than the value of the coal mined in West Virginia. The native peoples are wonderfully skillful in the hand trades, such as hand weaving, working in gold, silver, and brass, ivory carving, etc. These workmen have opposed the introduction of machinery, but with only partial success, for cotton factories, jute mills, sugar refineries, and other forms of manufacturing have been established. Since Great Britain is an exporter of manufactures, the British Government

naturally does not seek to build up manufacturing in its greatest colony, although it cannot be said that it actively opposes the development of manufacturing.

Relations with Great Britain. — India is officially called "The

FIG. 338. — Tin workings in the Malay Peninsula. This region, including near-by islands, supplies the greater part of the world's tin. (*Phila. Museums.*)

Empire of India"; the emperor is the king of England, who is represented by a governor-general sent out by the British Government. It will be seen from the map (Fig. 324) that British India has reached westward and absorbed Baluchistan, and has reached eastward and absorbed Burma. It is gradually reaching northward into Tibet and still farther westward into Persia. Two-thirds of the area of India is ruled directly by high British officials, but the vast majority of the lower officials are Hindus. Somewhat less than 150 small native states are still allowed to retain their native princes as nominal rulers, but these are also essentially

under British authority. Great Britain regards India as the choicest gem in her colonial empire; to bind it closer to the home country she secured the Suez Canal. Her trade with India is larger than that with any other of the British possessions. India is better off under British rule than it was before or would be for a long time to come under an independent government. Many Hindus, however, are dissatisfied and desire independence.

The Malay Peninsula

This small area and two Dutch islands near by contain the greatest known tin deposits in the world (Fig. 338). This general region, including the Dutch East Indies, also contains the greater part of the rubber plantations of the world, which yield 80 per cent of all the crude rubber that is produced. The Amazon Valley, once the leading producer, has declined rapidly in production. Singapore, a city at the very southern tip of the Malay Peninsula, is one of the great commercial centers of this part of the world.

Hongkong

Hongkong consists of an island and a small piece of mainland now belonging to Great Britain on the southeast coast of China (Fig. 324). On the island is the very important commercial city of Victoria. This great collecting and distributing center of the Far East is usually called Hongkong, not Victoria; it is one of the six greatest ports of the world.

Southwestern Asia

Great Britain has long held Aden, a city and strip of land at the southern corner of Arabia, guarding the southern outlet of the Red Sea, which is part of the Suez route to India. As a result of the World War Mesopotamia (in the valley of the Tigris-Euphrates) and probably certain other parts of the old Turkish Empire will pass under British influence (Fig. 324).

Australia and New Zealand

Australia. — Opened to settlement in 1788 and organized into a self-governing commonwealth in 1901, Australia has risen to an influential place in the British Empire. Though equal to the United States in area it has only 5,000,000 people; and

FIG. 339. — States and chief cities of the Australian Commonwealth.

only 10 or 12 per cent of its area has both a temperate climate and sufficient rainfall for agriculture. Owing to the position of the main mountain range close to the eastern (windward) side of the continent, over 40 per cent is desert, and about 28 per cent is suited only to pasturage (Fig. 340). Less than one per cent of the total area is cultivated and nearly one-half of this is devoted to wheat, the leading crop. The prevailing aridity of the climate causes Australia to be, in the main, a pastoral land,

and its 90,000,000 sheep make it the greatest exporter of wool in the world (Fig. 342); about 40 per cent of its exports consists of wool, the greater part of which is sold at the wool auctions of

FIG. 340. — Rainfall zones in Australia. (*Gregory in Nat. Geog. Mag.*)

Sydney, which are attended by buyers from all the principal wool-importing countries of the world.

Australia has important mineral resources, — gold, coal, tin, copper, silver, lead, zinc, and others (Fig. 343). It is one of the five leading gold producers of the world. Single gold nuggets worth $50,000 to $75,000 each have been found. The principal coal fields are near the east coast and send coal to California and South America. However, all the minerals produced are worth much less than the wool alone. Most of the people live in the southeastern part of the continent. The population is so small

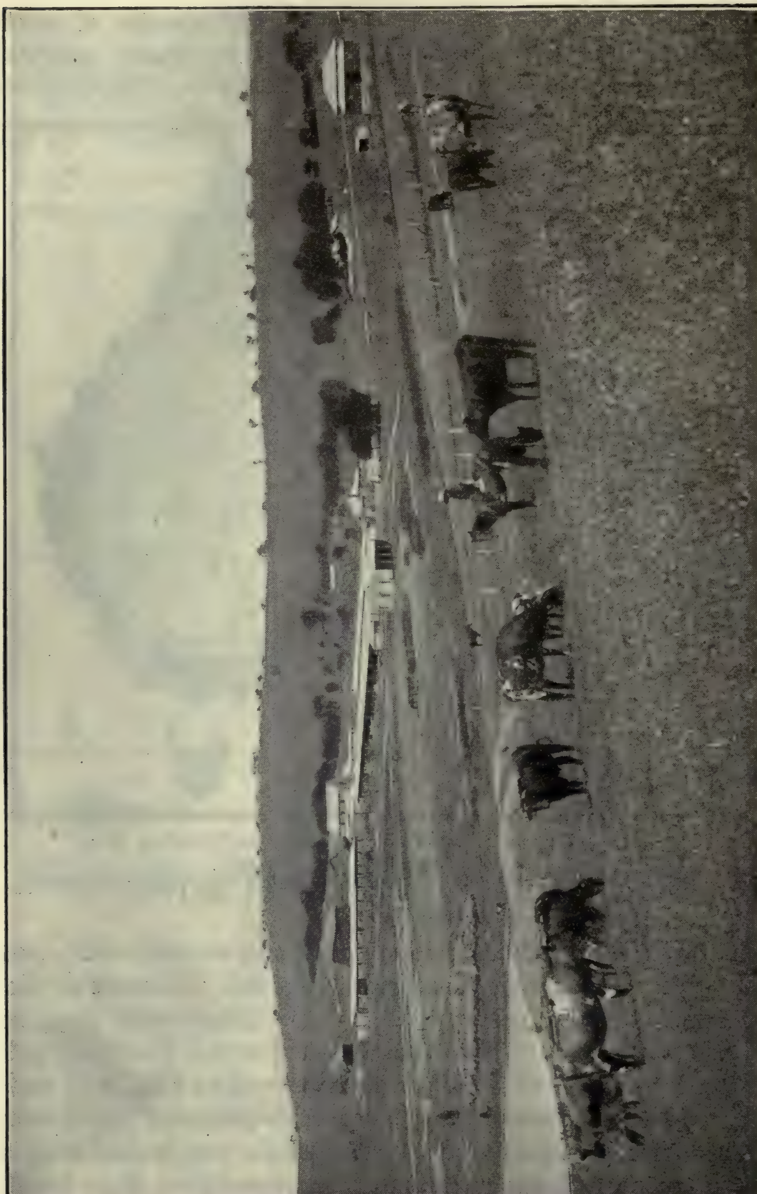


Fig. 341.—Grazing lands in South Australia. (*Physiography Lab. Cornell Univ.*)

FIG. 342. — Distribution of sheep in Australia and New Zealand: compare with the rainfall map, Fig. 340. (*U. S. Dept. of Agr.*)

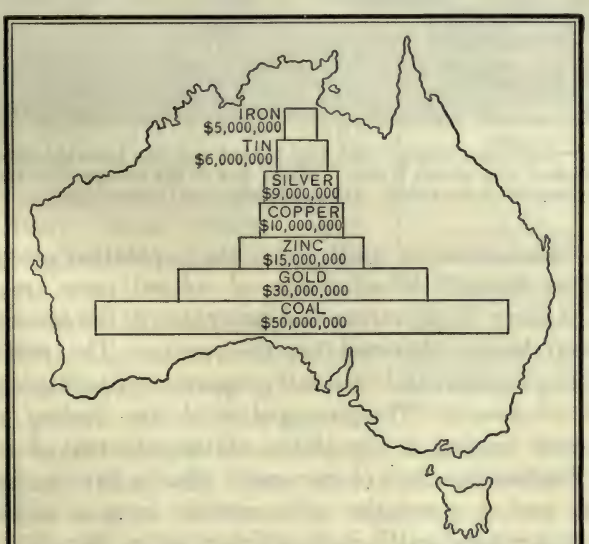


FIG. 343. — Approximate annual production of the chief minerals of Australia.

in proportion to the value of the products that the export trade is over $100 per capita, a figure reached by only a few countries in the world, and considerably greater than that of the United States at its highest. The people are nearly all of British an-

Fig. 344. — Loading a steamer with pigs of lead and zinc from the famous Broken Hill mines of New South Wales. This is one of the leading zinc and lead producing districts of the world. (*Physiography Lab. Cornell Univ.*)

cestry. Immigration is small, hence the population grows slowly. Strict laws against the admission of colored races are in force. The labor party is very strong and many laws of the commonwealth have been largely dictated by this party. The remote position of the continent and its small proportion of arable land hinder rapid development. The principal cities are *Sydney* and *Melbourne,* each having a population of three-fourths of a million.

New Zealand consists of two main islands having the area of Colorado and a population of somewhat over a million. The raising of sheep and cattle is the chief industry (Fig. 342). There are twenty sheep for every person on the islands. Meat, wool,

and dairy products are the principal exports. Both gold and coal are mined in considerable quantities. The overseas trade of New Zealand is very large in proportion to the population, in fact, greater than that of the United States. The per capita wealth of the people is also high, among the highest in the world.

British Possessions in Africa

About 40 per cent of the great continent of Africa and 40 per cent of its people are now under the British flag, or within the British sphere of influence (Fig. 324). By acquiring German East Africa, Great Britain now holds land or transportation rights extending the length of Africa, making possible the building of the "Cape to Cairo" railroad wholly under British control. In this vast area there is only a small proportion of white people, and these are chiefly in South Africa. The natives produce little that enters into international trade and they consume little that needs to be imported. With the exception of South Africa the British possessions in Africa have a relatively small present value, but that value will greatly increase with time.

Fig. 345. — The cotton producing lands of the Nile delta and valley. In value of cotton produced, Egypt ranks third, following the United States and India. (*U. S. Dept. of Agr.*)

Egypt. — After the outbreak of the World War, Egypt was definitely regarded as a protectorate of Great Britain; but in 1922, it was granted almost complete independence. Egypt consists of a small area of irrigated land, the delta and flood plain of the Nile, and a large area of desert. The irrigated portion is exceedingly productive and very densely populated. On an irrigated area smaller than the little state of New Jersey live

nearly as many people as inhabit the two vast countries, Canada and Australia. Irrigation in Egypt is discussed on page 176. Egypt produces a large variety of crops, including wheat, rice, sugar, and corn, but the one crop that overshadows everything else

FIG. 346. — The rising waters of the Nile in the annual overflow of its flood plain. (© *Keystone View Co.*)

is cotton (of high grade). Of somewhat over \$200,000,000 worth of products exported from Egypt in a recent year, \$167,000,000 consisted of cotton, the greater part going to England, but \$25,000,000 worth going to the United States.

The Suez Canal. — This famous canal about 100 miles long, connecting the Mediterranean and Red seas, was built under the direction of a French engineer and was opened to traffic in 1869, but later the British gained control of it. The canal nearly failed financially in the early years but is now exceedingly prof-

itable, for ships passing through pay toll. A ship of even moderate size pays as much as $5000 to $10,000 for one transit of the canal. It shortens the ocean route between Europe and the Orient by many thousands of miles. This link in the water route to India is of great importance to the British Empire.

Fig. 347. — One of the diamond mines of Kimberley, South Africa. The diamonds are found in the necks of extinct volcanoes. (*Physiography Lab. Cornell Univ.*)

South Africa. — This part of the world has become famous as the producer of nearly half of the world's gold and practically all of its diamonds. The diamonds are found in ancient lava which fills the necks of old volcanoes, mainly in the vicinity of the city of Kimberley (Fig. 347). The gold fields are somewhat farther north, near Johannesburg. Next to gold, wool is the largest product of South Africa, exceeding diamonds in total value.

The country is for the most part a plateau with light rainfall, better suited to sheep raising than to agriculture. The early white settlers were Dutch and their descendants, called Boers, make up the major part of the white people in large

sections of the country. The Union of South Africa is, like Canada, a self-governing dominion; *Cape Town* is the chief city.

Summary

For 400 years Great Britain has been a colonizing power. Century after century she has gone on acquiring new possessions by colonization and conquest until her colonial empire is the most extensive that any nation ever possessed. Hand in hand with this acquisition of new lands has gone the expansion of her commerce and the growth of her great manufacturing industries at home. The very life of the nation depends upon manufacturing, which is made possible by her great resources of coal. Her commerce consists in large part of selling these manufactures to her colonies and to other countries, and in return securing from them needed raw materials and foodstuffs. To do this requires ships in great numbers, and so Great Britain became the leading shipbuilder and ocean carrier. To protect her scattered colonies and her commerce requires a large navy and widely distributed coaling stations and naval stations. Her great coal resources near the sea permit the export of coal to many parts of the world that furnish return cargoes to British ships, thus cheapening ocean freight rates to the British Isles.

British capitalists have invested large sums of money in the colonies and in foreign countries. This has gone into railroads, public works, banks, etc., and the dividends and interest from these investments have flowed back to Great Britain. Moreover, British ships earn many millions of pounds sterling for their owners.

Canada, Australia, New Zealand, and South Africa are self-governing, almost independent, countries. If they chose to do so, they probably would be allowed to separate themselves from the Empire, but they prefer to remain under the British flag. The Empire of India, the most populous colony, is only partially self-governing, yet it is probably better off than it would be under any government or governments which it could independently maintain. However, India has many people who are dissatisfied

with British rule. Ireland has been granted a status about like that of Canada or Australia and is known as the Free State of Ireland. With the exception of Canada the commerce of the British colonies is more largely with the home country than with any other; yet no British colony has so much trade with the United Kingdom as has the United States or as Germany had before the war. Most of the materials needed in English industries are bought abroad; these include cotton from the United States, iron ore from Spain and Sweden, and petroleum from the United States and Mexico. As a result of the World War Britain greatly extended her territory in Africa and strengthened her position in southwestern Asia; but the war imposed an enormous debt upon the nation. The English-speaking peoples have risen to a commanding place among the nations, and if the highest ideals of these peoples can prevail their leadership will benefit the world.

EXERCISE XXVIII

Consult an Atlas; also Figs. 229, 298, 324, 350.

1. Locate Canada, Australia, India, New Zealand, British Guiana, Newfoundland, Suez Canal, Ceylon, Jamaica, Nova Scotia, Malay Peninsula, British Columbia, Egypt, province of Ontario, Province of Quebec, Burma, Wales, Malta, Gibraltar, Aden, Hongkong, Bermuda Islands, Bahama Islands.
2. Locate the following cities: London, Liverpool, Glasgow, Edinburgh, Dublin, Manchester, Calcutta, Bombay, Singapore, Melbourne, Sydney, Auckland, Halifax, Quebec, Montreal, Toronto, Winnipeg, Vancouver.
3. Where in the British Empire are the following produced in large quantities: tin, rubber, gold, coal, nickel, diamonds, cotton, rice, wheat, wool, forest products, silver?
4. Why is the climate of the British Isles exceptionally mild for their latitude?
5. Why is the geographical situation of the British Isles highly favorable for commerce?
6. Why are ocean fisheries especially important to a nation such as the United Kingdom?
7. Why do the British consider it necessary to maintain a large navy?
8. Why does the United Kingdom need a larger merchant fleet than Russia?
9. Why is the Suez Canal more important to the United Kingdom than to any other country?
10. Why is a large part of Australia a desert?

11. Why is sheep raising the most suitable industry in much of Australia?

12. Why has the population of Canada increased more slowly than that of the United States?

13. Why has the population of Australia increased slowly?

14. Why is foreign trade more necessary to the United Kingdom than to the United States?

15. Why does India have its rains chiefly in summer?

16. What reasons can you assign for the great power and influence of the British nation?

17. Suppose the coal of the British Isles were to become exhausted; what would be some of the important results?

18. Suppose the British Isles in time of war could be so effectively blockaded that no ships could enter or leave British ports; what would probably be the outcome? Why?

19. Where do the British cotton mills get the greater part of their raw cotton? Why is Great Britain very anxious to increase cotton growing within the empire? What parts of the empire would be best suited to cotton growing?

POLITICAL MAP OF
EUROPE
Scale of miles
0 100 200 300 400 500 600
Cities with over 1,000,000 London
Cities with 500,000 to 1,000,000 Liverpool
Cities with 200,000 to 500,000 Sheffield
Smaller places Dundee
Capitals with less than 200,000 Berne
Capitals Other cities
Boundaries not yet decided
ARCTIC
ARCTIC CIRCLE
ICELAND
Reykjavik
Mt. Hekla
FAROE ISLANDS (To Denmark)
SHETLAND ISLANDS
ORKNEY ISLANDS
HEBRIDES
LOFODEN ISLANDS
Christiansund
Trondhjem
Bergen
Christiania
Stavanger
Christiansand
Skagerrack
Kattegat
NORTH SEA
Aberdeen
Dundee
Glasgow
Edinburgh
GREAT BRITAIN
Newcastle
Belfast
IRELAND
IRISH FREE STATE
Dublin
Cork
Queenstown
Irish Sea
Leeds
Hull
Liverpool
Manchester
Sheffield
Birmingham
ENGLAND
WALES
Cardiff
Bristol
London
Plymouth
Southampton
Portsmouth
Dover
English Channel
Cherbourg
Brest
Havre
Paris
Reims
Verdun
Metz
Strassburg
Lille
Calais
Ostend
Amsterdam
The Hague
Antwerp
Rotterdam
NETHERLANDS
BELGIUM
Brussels
LUXEMBURG
SAARE
Nantes
Loire R.
Seine R.
Tours
Dijon
FRANCE
Limoges
Lyon
St. Etienne
Geneva
Bordeaux
Garonne R.
Toulouse
Rhone R.
Marseille
Nice
Bay of Biscay
ATLANTIC OCEAN
Cape Finisterre
Oporto
PORTUGAL
Lisbon
Douro R.
Tagus R.
Guadiana R.
C. St. Vincent
CANTABRIAN MTS.
Bilbao
Ebro R.
PYRENEES
ANDORRA
SPAIN
Valladolid
Madrid
Valencia
Cordoba
Seville
Cadiz
Cartagena
Malaga
Barcelona
Gibraltar (Br.)
Strait of Gibraltar
Tangier
BALEARIC IS.
MINORCA
MAJORCA
IVIZA
CORSICA
SARDINIA
Cagliari
MEDITERRANEAN
AFRICA
Fez
Morocco
Oran
Algiers
Tunis
MALTA (Br.)
SICILY
Palermo
Messina
Mt. Etna
Catania
Strait of Messina
ITALY
APENNINES
Rome
Naples
Mt. Vesuvius
Taranto
Brindisi
Milan
Turin
Genoa
Venice
Trieste
Goritz
Po R.
Bologna
Florence
Leghorn
ALPS
Adriatic Sea
Fiume
Drave R.
Save R.
Cetinje
Tirana
SWITZERLAND
Berne
Zurich
Basel
Rhine R.
Danube R.
Munich
Stuttgart
Frankfort
Cologne
Leipzig
Dresden
Prague
GERMANY
Hamburg
Bremen
Elbe R.
Hanover
Berlin
Stettin
Oder R.
Breslau
Lodz
Danzig
BALTIC
DENMARK
Copenhagen
Helsingborg
Goteborg
L. Wenner
L. Wetter
GOTLAND
OLAND
Stockholm
Upsala
Soderhamn
Umea R.
Vienna
AUSTRIA
Budapest
Danube R.
Williams Engraving Co., N.Y.
Longitude West
Longitude East

FIG. 348

FIG. 348

CHAPTER XXIII

CONTINENTAL EUROPE

European Leadership. — Europeans and their descendants dominate most of the world. Europeans discovered and colonized the western hemisphere, and their descendants now occupy it. Europeans have taken possession of Australia and nearly the whole of Africa; they rule more than half of Asia and practically all the islands of the sea. European civilization has spread over the earth; it seems to have won because of its superiority (Figs. 349, 350).

To what is this conquering and dominating power of European peoples due? No one can regard it as a mere accident; there must be a cause or a combination of causes. To say that this superiority is something in the peoples themselves and to account

MILLIONS OF SQUARE MILES

AREA OF EUROPE 3.9	AREA OF NATIONS OF EUROPEAN ORIGIN CHIEFLY IN NORTH AMERICA AND SOUTH AMERICA 17.5	AREA OF DEPENDENCIES OF EUROPEAN NATIONS 28.6	AREA OF ALL OTHER LANDS 8

Fig. 349. — Proportional areas, showing the extent of European domination.

for it by saying that some races are stronger and abler than others is no answer. We want to know, if we can, *why* Europeans became superior to most other peoples. Is their power of leadership due to something in the climate in which they have lived, or in

the configuration of the continent, or in its productions, or in its position with reference to the other continents, or to something else? Probably all these factors have done something to

POPULATION OF EUROPE 470,000,000	POPULATION OF NATIONS OF EUROPEAN ORIGIN CHIEFLY IN NORTH AMERICA AND SOUTH AMERICA 205,000,000	POPULATION OF DEPENDENCIES OF EUROPEAN NATIONS 515,000,000	POPULATION OF ALL OTHER NATIONS 510,000,000

FIG. 350. — The areas of the four spaces in the above diagram are proportional to the respective populations as indicated. The figures are approximations in round numbers.

create the characteristics which Europeans have acquired during past centuries. Most Europeans were barbarians when we first know of them; and from this condition of barbarism they have been changed into the most enlightened and most masterful people in the world.

The Climate of Europe as a Whole. — Europe is the most northerly of the continents; not only does it lie almost wholly in the temperate zone, but it lies in the northern part of that zone. Both Asia and North America extend far enough south to reach well within the tropics; not so with Europe, whose southernmost point is in latitude 38° (15° north of the tropic). Every part of Europe has those distinct seasonal changes which are found only in the temperate zones. Every part of Europe has a winter and a summer; and every country has snow, though snow does not fall in every part of these countries.

All great peoples are or have been agricultural peoples. The desert, the tropical jungle, and semiarid steppe, or the tundra, cannot produce great nations. It is noteworthy that Europe has the smallest proportion of nonagricultural land of any of the continents. It is the only continent without a desert, and almost everywhere the rainfall is sufficient for crops (Fig. 351).

Europe is in the belt of prevailing westerlies, which bring rapid and extreme changes of weather. Much as we may dislike these

constant changes, they are believed to be beneficial. There is little doubt that mental and physical vigor, the work habit, the practice of taking thought for the future, of laying up something, and of getting work done when there is opportunity are

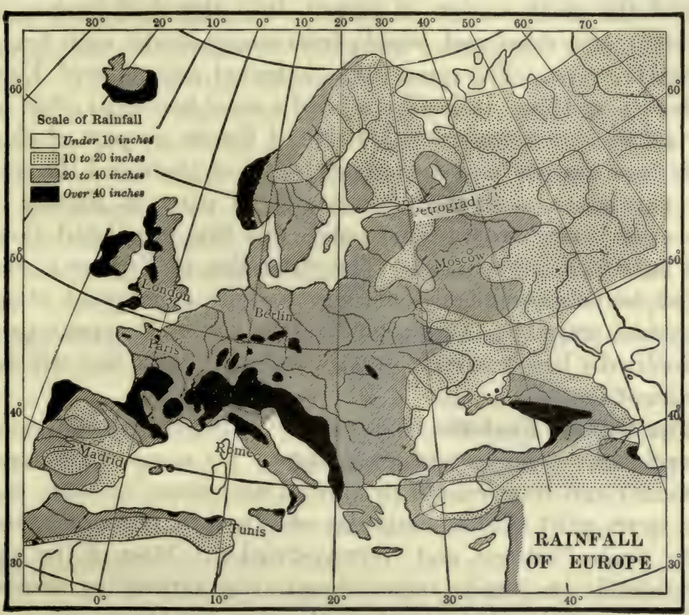


Fig. 351. — Rainfall map of Europe. (*Tarr.*)

traits most conspicuous in the peoples who have been exposed to these rapid changes of weather and to distinct changes of seasons. The cold weather renews our vigor and makes us enjoy work. The enjoyment of work, the love of achievement, the aggressiveness and progressiveness of the leading European and American peoples are directly connected with the climate under which for centuries they have lived.

The Remarkable Coast Line of Europe. — No other continent has a coast line which approaches that of Europe in irregularity. Peninsulas, large and small, protrude from almost every part of the continent, and long arms of the sea reach far into the land;

there are many islands, and many estuaries. All of this has had somewhat to do with the rate of progress and the position of leadership which Europe has achieved. Countries progress by the exchange of ideas. Commerce, especially sea-borne commerce, is one of the great carriers of ideas. Into the chief harbors of a country come ships and people from many lands, each bringing something new. The remarkably indented coast line of Europe, with its islands and inclosed seas, had a most beneficial effect upon navigation and commerce. Outside of Russia no part of Europe is far from the sea, and so various articles of trade and the traders who carried them reached into nearly all parts of Europe. Information spread from place to place and this stimulated thought and suggested other ideas. The coast line of Europe is ideally suited to this commercial activity and its consequent stimulus to mental activity. Another aid to the rise of European peoples undoubtedly has been this greatly indented coast line which the continent has.

The Surface Features of Europe. — Europe is a continent of exceptionally complex surface features. Its mountain ranges are scattered and they extend in various directions; to these mountain spurs most of the peninsulas are due; for example, Greece, Italy, Spain-Portugal, and Norway-Sweden. Most of the important islands are due to mountainous areas protruding above the sea; for example, Sicily, Sardinia, Corsica, the Greek archipelago, and the British Isles. The people of each of these peninsulas and each of the larger islands, being somewhat set off by themselves, developed their own peculiarities, their own ways of thinking and doing, their own languages, customs, and ideas. Yet these various peoples were isolated only in part, for there was communication among them. They traded and traveled in one another's lands. There was a constant exchange of ideas. The physical barriers that separated them were sufficient to enable each country to develop and preserve, in a measure, its own type of civilization, but they were not sufficient to prevent that interchange of ideas which made each country a sharer in the progress of all the others. Thus did Europe's diversity of sur-

face tend to produce diversity of peoples whose intercourse carried the peoples forward in civilization. Herein seems to be a third reason for the rapid rise of Europe to its place of world leadership.

The Rivers of Europe. — Europe is too small to have rivers of great size, but many of them are extensively used for navigation. This is partly due to the dense population in Europe. The Rhine, the Volga, and the Danube are the most important. The Rhine and the Volga are described in Chapter IX. The Danube rises in the Alps, the chief watershed of Europe, and flows into the Black Sea. It has large navigable branches in the rich agricultural lands of Hungary and Rumania. The main river is also an important waterway for parts of Serbia and Bulgaria. At the "Iron Gate" the river has carved a deep gorge through the mountains, and here the channel has been made navigable by expensive improvements.

The Rhine, Elbe, and Oder, whose courses are chiefly in Germany, and the Vistula in Poland, have all been made "international rivers," governed by international boards, so that the different countries through which they flow may use them in common. The Elbe and the Oder give the new nation of Czechoslovakia water connection with the sea.

The rivers of France, especially the Seine, Loire, Saône, and their largest branches, have been improved and connected by canals so that boats of moderate size may pass from river to river and may also reach the rivers of Belgium and Germany. All of the more important rivers of Germany and a few of those of Russia are also connected by canals. These interior waterways of Europe are used more than the rivers of the United States.

In Great Britain inland waterways are not important, except the mouths of rivers like the Thames, Mercy, Tyne, and Clyde, whose estuaries form the chief harbors of the British Isles.

The Po is the only river of Italy of any size. The river and its tributaries flow through a very fertile flood plain which they have built, and they supply water for the irrigation of some 140,000 acres of agricultural land.

The Races of Europe. — This topic can be discussed here only in a very general way. With a few unimportant exceptions all the European peoples belong to the white race. The Lapps and Finns of the Far North, the Hungarians, and the European Turks are descended from peoples of the Mongolian or Yellow race, but they have been so long in Europe that the difference between them and the other Europeans is not necessarily greater than the differences among some of the white Europeans themselves.

Europe has three major racial groups: (1) the Latin or Mediterranean group, including Italians, Spanish, Portuguese, and the French in part; (2) the Teutonic group, including the English, Scandinavians, Dutch, Germans, and German Austrians, and an important element of the French and the Belgians; (3) the Slavs, including the majority of the Russians, Poles, Bohemians, and a large part of the Balkan peoples. Besides these three major groups, several million Celts are found in Wales, Ireland, Scotland, and Brittany in France, and the French as a whole have a large amount of Celtic blood. The Latin peoples are largely Roman Catholics in religion, a majority of the Teutonic peoples are Protestants, and the Slavs are mainly Greek Catholics.

Each of the three principal racial groups of Europe has produced one or more strong nations: Russia among the Slavs; Italy and France among the Latins; Great Britain and Germany among the Teutons. Since the United States, Canada, Australia, and New Zealand must be considered mainly Teutonic, it is evident that the Teutonic peoples are the most influential racial group. Among the Teutonic nations the English-speaking people are most numerous and most powerful. It seems clear that there is something in the climate of the belt of prevailing westerlies that imparts mental and bodily vigor, ambition, and determination, and helps to make strong nations.

The Mineral Resources of Europe

Coal and Iron. — Europe could not have become the ruling continent that it is if it had not been rich in minerals. No modern

country can become a first-class power that does not either have coal and iron within its own borders or have easy access to them. In the present industrial and commercial age the rank of a country as a world power is closely connected with its use of coal and iron.

Unlike South America, Europe has many coal fields and much iron ore (Fig. 352). Great Britain is the largest producer of coal

FIG. 352. — Average annual production of coal and iron in western and central Europe.

in Europe, and for a long time was the greatest exporter in the world; Germany came second, followed by France and Austria-Hungary, but the World War so upset production that comparative figures have lost their meaning. Russia has valuable coal mines in the south, and Belgium has part of the coal beds that extend into northern France. Of the leading nations of Europe, Italy alone has almost no coal, a most serious drawback to that country. During the war and since, Italy has suffered greatly from this

lack. Spain has coal beds, but only a small amount is mined. Holland, Switzerland, and the three Scandinavian countries have no coal at all, or very little, and the Balkan Peninsula has but little. The new states of Poland and Czechoslovakia have valuable coal mines, and these will greatly aid these countries in their struggle for national existence.

Iron ore is more widely distributed than coal. Great Britain produces about half of the iron ore she uses. France now has more than her industries demand, for she again has the mines of Lorraine, which Germany developed into the largest producers in Europe. Germany lost her best mines and will not have enough for her own needs, a severe blow to her industries. Some of the best iron deposits of Austria-Hungary were in Styria and these now belong to the new republic of Austria. Russia and Sweden have exceedingly valuable beds of the highest grade, but most of the Swedish ore must be exported because of lack of coal to smelt it. Spain has important iron mines, especially in the north near the Bay of Biscay; the larger part of this goes to the British Isles for smelting and for use in manufacturing. Italy mines a little iron but not enough for her own needs. Norway, Denmark, Holland, Switzerland, Portugal, and the Balkan Peninsula either yield no iron ore or yield very little. Taken as a whole, Europe is the greatest producer of coal and iron among the continents, in fact, produces as much as all the rest of the world. This is another of the reasons for the place of leadership which Europe occupies.

Petroleum. — Outside of the important Russian oil fields of Baku on the shore of the Caspian Sea, Europe produces comparatively little petroleum. A moderate amount is obtained in Rumania and a still smaller amount in Galicia and Alsace. The Russian field is an uncertain producer and Europe is depending mainly upon the United States and Mexico for petroleum and its products.

Copper, lead, and zinc are mined in considerable amounts in Spain and in Germany. Russia has copper deposits and Italy has valuable zinc deposits in Sardinia, but the largest zinc mines

of Europe are in upper Silesia, which have been divided between Poland and Germany.

Silver, Gold, and Platinum. — Though Europe has nearly all other minerals, it produces so little gold and silver that they scarcely deserve mention, but this lack is of small importance, for these metals pass from country to country with great ease. Most of the world's platinum — more valuable than an equal weight of gold — came in the past from the Ural region of Russia.

Nonmetallic Minerals. — These include the various kinds of salts, the building stones, clay, etc. Some of these are found in almost every country. There are wonderful deposits of common salt in Poland. Germany has almost a monopoly of potash salts, but lost one important deposit when Alsace was ceded back to France. Statuary marble of great purity and whiteness is found in certain islands south of Greece and in Italy. Porcelain clays of the finest quality are found in many parts of Europe, notably France, Holland, Austria, and Germany; famous porcelains are manufactured in each of these countries. Great quantities of sulphur are obtained from the volcanic region of Sicily. Other minor minerals are obtained in Europe but they cannot be named in detail here.

Food Production in Europe. — Europe, as a whole, is a great producer of food. This has been made necessary by the dense population. The United States produces more food than any European country, yet Europe as a whole produces more than any other continent. With the exception of the Mediterranean region, the crops of Europe are much the same as those of the northern United States. Wheat and rye are the great breadstuffs (Figs. 353, 354); corn is confined mainly to the Po Valley, the Danubian region, and southern Russia. Ten times as many potatoes and several times as many sugar beets are grown in Europe as in North America (Fig. 355). Barley and oats are important, but mainly for animals. The raising of live-stock for milk, meat, hides, and skins is an important occupation in nearly every European country.

Land in central and western Europe is much more carefully

cultivated than in the United States. In parts (Belgium, for example) spade agriculture is common, and the land is made to yield very large crops. In Russia, Poland, Denmark, Ireland, Hungary, Rumania, the Balkan States, Italy, Spain, and Portugal,

FIG. 353. — Distribution of wheat production in Europe. (*U. S. Dept. of Agr.*)

agriculture is the leading occupation of the people. In Germany, Holland, France, and Sweden it occupies from one-third to one-half of the population. In Great Britain, Belgium, and Switzerland it is less important than manufacturing. Even in England, Belgium, northern France, and in western Germany, where manufacturing towns are so numerous, the agricultural land is intensively cultivated. Under normal conditions, eastern Europe produces a surplus of foodstuffs; middle Europe is nearly self-sufficient, but western Europe must import food in large quantities. Great Britain produces only one-fourth to one-third of the food that her people require. Europe is the chief buyer of the world's surplus food products.

The Forests and Forest Industries. — Aside from some of the Mediterranean lands and the southern third of Russia, most of

Europe was originally covered with forests, as lands usually are where rainfall is ample. Gradually these forests have been cut off wherever the land was suitable for crops, for the increasing population demanded more and more food. The only great for-

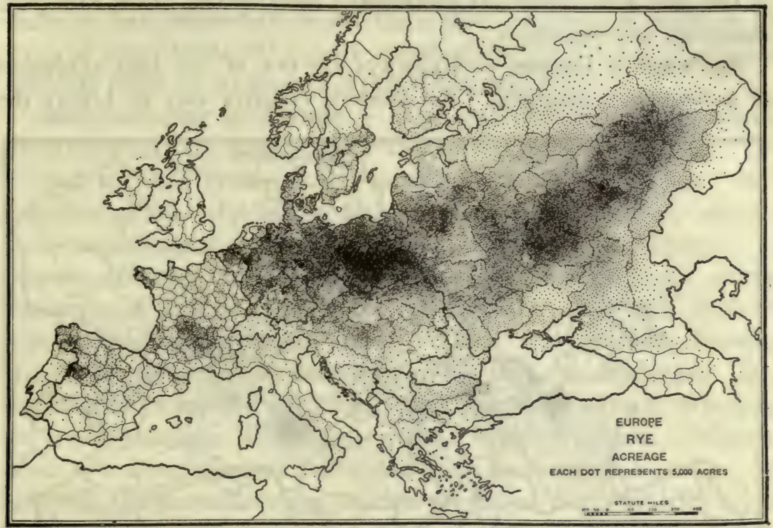


FIG. 354. — Two-thirds of the rye of the world is grown in Germany and Russia, where it is the chief breadstuff of the people. (*U. S. Dept. of Agr.*)

est areas left are those of Sweden, Finland, and northern Russia, which supply the major part of the export timber of Europe. The mountainous portions of other countries still retain more or less of their forests, but western Europe imports a large part of its lumber, timber, and other wood products. So keenly have Germany, France, and Switzerland felt their lack of timber that they are reforesting their nonagricultural lands. In Germany the forests have been managed with exceptional care, a tree being planted whenever one was removed. Americans, who use wood, lumber, and timber extensively, do not appreciate how carefully wood is conserved in many European countries, where peasant women go to the woods and gather up little twigs scarcely larger than a lead pencil and carry them home for fuel. With us wood for

fuel is sold by the cord; in parts of Europe it is quite commonly sold in little bundles.

Most paper is now made from wood pulp. Sweden and Finland are exporters, while Germany and Austria-Hungary were in the past also important producers; most of the other European countries are importers.

Railways in Europe. — Railways are one of the best evidences of a country's progress. No modern country can be highly de-

Fig. 355. — In normal times, great quantities of sugar beets are grown in France, Germany, Russia, and adjacent countries. Before the World War about half of the world's sugar was made from cane and half from beets. (*U. S. Dept. of Agr.*)

veloped without a network of railways, and the modern development of a country usually is in proportion to the development of its railways. The British Isles, France, Germany, Belgium, Holland, southern Sweden, northern Italy, Austria, and Switzerland have very complete railroad systems, including trunk lines and branch lines. Outside of the British Isles the majority of the railways are owned and operated by the various governments. In Spain, Norway, Russia, and the Balkan States, rail-

road building has not progressed so far as in the countries mentioned in the first group. Naturally in a country like Russia there are large areas without railways. As a whole, Europe is not so well supplied with railways as the United States. Europe has somewhat more than 200,000 miles of lines in an area of over 4,000,000 square miles, while the United States has 260,000 miles in an area of 3,000,000 square miles.

Manufacturing in Europe. — It is well known that as countries progress they engage more and more in manufacturing. The extent to which this can be carried depends partly upon their supplies of coal and iron. It has been pointed out that eastern and southeastern Europe are predominantly agricultural. In Russia, Hungary, the Balkan States, Spain, and Portugal manufacturing is decidedly second to agriculture. The new state of Czechoslovakia, northern Italy, Poland, and southern Sweden are well advanced in manufacturing. France, Germany, and Holland have reached the stage where their interests are as largely in manufacturing as in agriculture, while England, Belgium, and, to a lesser degree, Switzerland, are industrial countries. In general, the manufacturing centers are on or near the coal fields, though this is not always true; for example, Switzerland, northern Italy, and Holland import their coal. Manufacturing leads to large cities and a congested population. From the map (Fig. 352), the section where manufacturing is most highly developed may be judged from the amount of coal produced. No single country in Europe does even one-half as much manufacturing as the United States, yet middle and western Europe as a region have nearly three times the population and do twice as much manufacturing as the United States. Among the continents Europe is the leader in manufacturing, as it is in agriculture.

The Foreign Commerce of Europe. — There are upwards of twenty-five different nations in Europe; leaving out Russia, all of the others together do not equal the United States in area. There are so many different nations that a large proportion of their commerce passes from one country to another and hence is recorded as *foreign* commerce. In the United States where 48

states belong to one nation the commerce is very largely from state to state and is not counted as foreign commerce. Partly for this reason and partly because of an early start Europe is the foremost continent in foreign trade; in fact, it carries on more than all the other continents combined. Relatively new countries like the United States, Argentina, Brazil, and Australia are likely to export more than they import, while older and more densely populated countries like most of those of Europe are likely to import more than they export.

In normal times, the foreign trade of the United Kingdom exceeds 6 billion dollars. In 1913, the last full year before the War, that of Germany reached nearly 5 billion dollars; that of France, Holland, Belgium, Russia, Austria-Hungary, and Italy (in this order) ranged from 3 billion down to 1 billion dollars respectively. A large part of the exports from western Europe consists of manufactures, while the imports are most largely foodstuffs and raw materials to be used in manufacturing. Russia and southeastern Europe, however, export foodstuffs and raw materials and import manufactures.

The great commercial ports of Europe are London and Liverpool in England, Hamburg and Bremen in Germany, Antwerp in Belgium, Rotterdam in Holland, Marseilles and Havre in France. Locate these on a map. (Fig. 348.)

France

Rank among the Nations. — For hundreds of years France was the leading nation of the world; the French language was the court language of Europe. French literature, art, manners, and education were regarded as standards of excellence. The long series of wars with England finally ended with the defeat of Napoleon at Waterloo in 1815, and since that time France has not occupied the place of leadership which she so long held. The crushing defeat of the French armies by Germany in 1871 still further reduced the prestige of France, but it has been partly regained by her victory in the World War.

In many respects the French still hold an advanced position among European peoples: they are intellectually keen and alert; their schools and universities produce men of very fine scholarship; their manufactures are peculiarly artistic; the people are fond of pleasure and gayety, yet exceedingly thrifty. No other people have such an ingrained habit of saving as have the French, and as a result France became a very wealthy nation, though the losses arising from the late war were terrible.

Fig. 356. — Location of the coal deposits of France. (*After Blanchard.*)

The French seem to lack either the capacity or the daring to undertake commercial and industrial enterprises on the large scale employed by the Americans, the British, and the Germans; they did, however, build the Suez Canal. The high position among the nations held by the French is due more to their intellectual and artistic qualities than to the magnitude of their undertakings. From the days of Lafayette down to the present, France and the United States have been warm friends, and our entrance into the World War was partly due to that friendship.

Favorable Conditions. — As a country France has certain important geographical advantages; among them are:

(1) A superior geographical situation

(2) An excellent climate

(3) A high proportion of agricultural land

(4) Very large resources of iron, considerable coal, and great potential water power.

In addition to these gifts of nature, France has built (5) one of the finest systems of highways in the world, (6) an excellent system of inland waterways, (7) an excellent system of railroads, (8) has achieved a foremost place in high-grade manufactures, and (9) has acquired colonial possessions second only to those of Great Britain.

Geographical Position. — France has a most excellent position for ocean commerce, for the country touches the English Channel, the Atlantic, and the Mediterranean. The only easy natural route from the Mediterranean to northwestern Europe is through France by way of the Rhone-Saône Valley. France is lacking in first-class natural harbors, but extensive improvements have been carried out at Marseilles, Havre, Bordeaux, Brest, and several other ports, making them serve well the needs of commerce.

Advantages of Climate. — With the exception of the large number of rainy days in northern France (200 a year), the climate is one of the best in Europe. The Mediterranean coastal region has dry summers and much sunshine; here the rain falls chiefly in winter. In most of France the westerlies, blowing off the Atlantic, make both the summers and the winters mild and give plenty of rainfall for agriculture. All of France is farther north than Chicago or New York.

Mineral Wealth. — With the exception of iron, France is not rich in minerals. Even with the Sarre coal fields obtained from Germany, France will not have enough coal for her needs. The principal coal fields are in the extreme northeast, extending into Belgium; smaller deposits are found in several other parts of the country (Fig. 356). When Lorraine was ceded back to France in 1918, France came into possession of the chief iron ore fields of Germany and now has an abundance of iron. France is one of the leading producers of aluminum in the world and has pottery clays of the finest quality.

Food Production. — Nearly one-half of France is agricultural

land and one-fifth is pasture; only 15 per cent is waste land. The Paris Basin is the garden spot of the country and one of the very best agricultural sections of Europe. The French soil as a whole is far more fertile than that of Germany. French farmers are very industrious and famously thrifty, but not scientific; yet the country produces about 75 per cent of the food that it uses. Wheat is the principal crop; in fact, France is one of the leading wheat growers of the world (Fig. 353). All of the other grains are raised, including corn (in the south). More potatoes and sugar beets are raised than in the United States (Fig. 355). France has large numbers of sheep, cattle, and horses, yet is not a leader in the raising of live stock. France is to a large extent an agricultural country; over 40 per cent of her people are engaged in farming, as against 8 per cent in Great Britain. No less important is the fact that 80 per cent of the farms are cultivated by their owners and not by tenants.

FIG. 357. — Principal wine regions of France. (*After Blanchard.*)

The Vineyards. — These are the most important in any country. They are found especially in the valleys of the south and west, but the famous vineyards of Champagne are in the east of France (Fig. 357). In a normal year France makes upwards of a billion gallons of wine and consumes even a greater amount; more is imported than is exported. The French vineyards produce an average of 500 pounds of grapes for every person in the country.

French Manufactures. — French goods are famous for their fineness, beauty, artistic finish, and superior style. French silks, velvets, tapestries, laces, fine cottons and woolens, millinery, porcelain, and art goods are, as a whole, the most beautiful made by any people. A large proportion of the French exports are

FIG. 358. — The beet sugar region of northeastern France, almost wholly within the battle lines during the World War. Each dot represents a sugar factory. (*Courtesy Am. Sugar Ref. Co.*)

luxuries rather than necessities. In total value of manufactures France now ranks third, following the United States and the United Kingdom. Lyon and the surrounding region is devoted to the manufacturing of silks. Marseille specializes in olive oil, soaps, and other oil products. The great manufacturing section, however, is in the northeast, extending from Paris to the Belgian boundary (Fig. 358).

Foreign Trade. — In value of foreign trade France ranks third among the nations, yet it is far below that of the United States and the United Kingdom and is below what might be expected of a country so ideally situated as France is. The French have not pushed their foreign trade so vigorously as the English and Americans have, perhaps because the French business man is

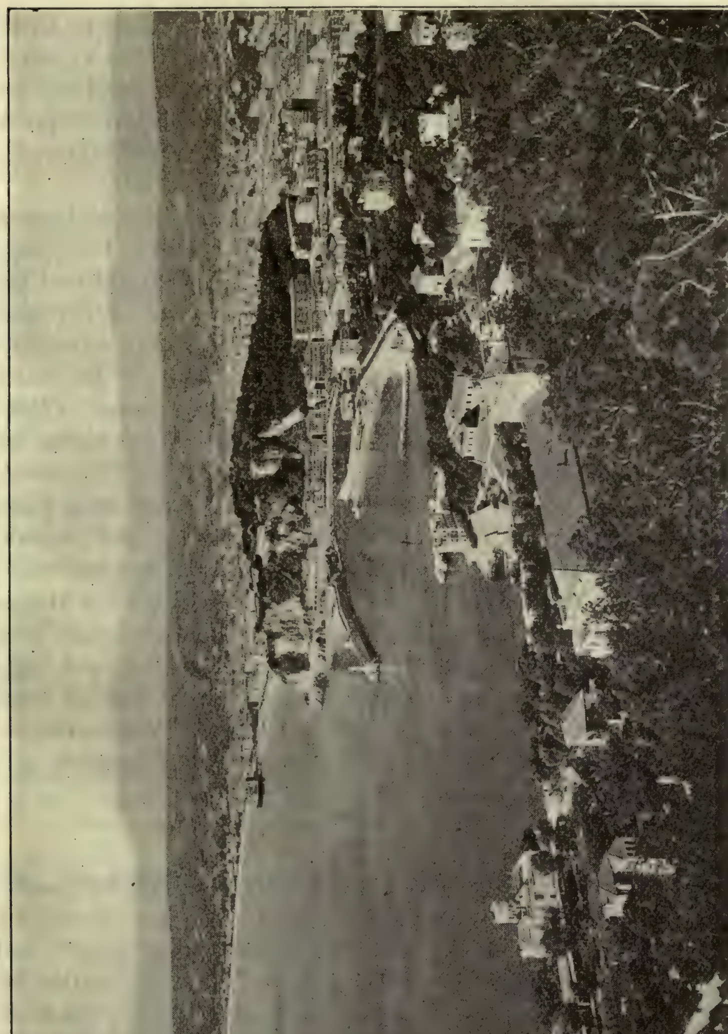


FIG. 359. — The beautiful City of Nice on the Mediterranean coast of France. (*Physiography Lab. Cornell Univ.*)

content with a modest fortune and likes to enjoy it while he lives. As in most European countries, the imports exceed the exports; the latter are mainly luxuries, such as silks, fine cotton and woolen fabrics, wines, automobiles, art goods, etc. The chief imports are quite the opposite in character, being bulky raw materials, such as wool, cotton, grain, coal, coke, and the metals.

Cities. — To a remarkable degree the national life of France centers in *Paris*, the third city of the world in size. It is near the center of the rich Paris Basin, the chief agricultural and industrial section of the country. It is noted for its beauty and gayety and probably is visited by more foreigners than any other city in the world. *Marseille*, on the Mediterranean, is the chief port of France, followed by *Havre* on the English Channel; *Lyon* and vicinity are famous for silk manufacturing and *Bordeaux* for its wine trade. *Rouen, Lille, Boulogne, Calais, Nice* (Fig. 359), *Brest, Metz, Strassburg, Reims*, and *Verdun* should be located on a map.

French Colonies. — These are chiefly in Africa and include Tunis, Algeria, Morocco, most of the Sahara, and tropical colonies reaching to the Gulf of Guinea; also the large island of Madagascar (Fig. 298). Besides these, France holds French Indo-China in southeastern Asia, French Guiana in South America, and various islands. Next to Great Britain, France is the leading colonial power of the world. The colonies on the Mediterranean in North Africa, particularly Algeria, are the most valuable and are making notable progress under French rule.

Summary

France is smaller than Texas in area, has about 40,000,000 people, 40 per cent of whom live on farms. The French are famous for their patriotism, their thrift, their workmanship, their gayety, and their intellectual achievements. France has an ideal situation for ocean commerce, has a large proportion of fertile land, a good climate, abundance of iron (but not of coal), and a long coast line with fair natural harbors. Her manufactures are renowned for their artistic finish; her foreign trade is large but not so large as might be expected; her colonial empire is second only to that of Great Britain.

GERMANY

The Ruin of Germany. — In the years preceding 1914 Germany had become one of the greatest nations in the world. In industry, in commerce, in science, in education, and in nearly all other fields of activity, Germany was in the very front rank of nations.

FIG. 360. — Some of the geographical changes in Germany resulting from the World War. (*Modified from map in Journal of Geography, Sept., 1919.*)

Had the nation continued its peaceful course it seems unquestionable that Germany would have become the leading nation of the world. But the warlike spirit and the ambitions of her ruling class plunged the world into the most terrible war of all time, and Germany emerged from it almost wrecked. By the terms of the peace treaty Alsace and Lorraine were returned to France. The German portion of Poland was restored to that country (Fig. 360). Her navy and merchant marine and all of her colonial possessions were lost. Most of her fortifications

were ordered demolished. Her chief rivers were internationalized and an enormous payment for damages was assessed upon her. The old autocratic government has been overturned and a republic established; the immediate future is uncertain, but the German *people* remain and will probably again become powerful in Europe.

Geographical Conditions. — Germany has a present area of considerably less than 200,000 square miles and a population of about 60,000,000. The northern half of the country is a sandy plain, naturally infertile but intelligently cultivated. The southern half is more or less mountainous. The climate is much like that of the central United States; the winters are most severe in the east, for western Germany feels the tempering influence of the winds from the Atlantic. The rainfall is everywhere sufficient for agriculture. The Baltic seacoast is low and sandy and poorly suited to ocean commerce. The short strip of coast on the North Sea carried on most of the sea-borne trade, mainly through the ports of Hamburg and Bremen, but also through ports in Belgium and Holland. The rivers flow from south to north across the country and are much used for navigation; this is especially true of the Rhine. (See page 163.) Germany has the best system of internal waterways in Europe, but by the terms of the peace treaty the larger rivers are internationalized. Lying in the very heart of Europe and touching most of the principal countries of the continent, Germany has an excellent position for overland commerce.

Minerals and Forests. — Germany still has much coal, though some was lost by the war; the best of her iron ore deposits, those of Lorraine, also were lost. Enough coal, but not enough iron ore, remains for the country's immediate needs. The only important potash deposits in the world are in Germany, and the more valuable of these beds (at Stassfurt) are still retained. Copper, lead, zinc, a little petroleum, and several other minerals are produced. Most of the nonagricultural or nongrazing land is devoted to forests carefully managed by government officials.

Agriculture. — While Germany has become a great manufac-

turing country, agriculture is still the occupation of about 40 per cent of the people. Enormous quantities of potatoes, rye, and sugar beets are produced. Under normal conditions Germany produces four times as many potatoes (Fig. 361), three times as

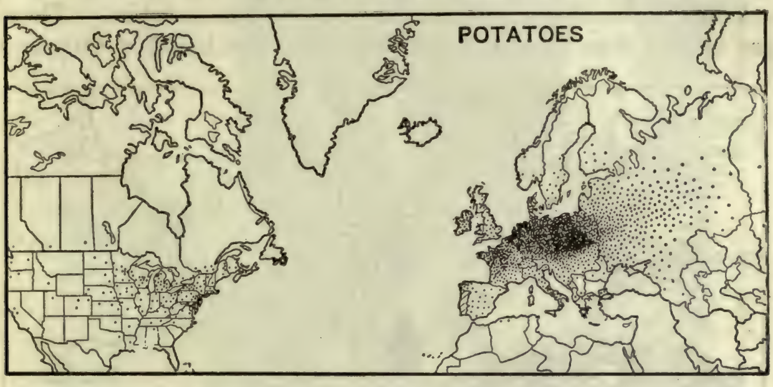


FIG. 361. — Over 90 per cent of the potatoes of the world are grown in Europe. Germany alone, under normal conditions, produced nearly five times as many as the United States. (*U. S. Dept. of Agr.*)

many sugar beets (Fig. 355), and fifteen times as much rye (Fig. 354) as the United States, but only one-seventh as much wheat and almost no corn. All the crops of cool temperate climates are grown, and the country is normally able to produce from 75 to 80 per cent of the food that its people require. Farm labor is done by women as well as by men, as it is throughout the continent of Europe; on the whole, agriculture in Germany is conducted on a more scientific basis than in most other countries.

Manufacturing. — Before the war Germany ranked third as a manufacturing nation and was rapidly rising to second place. The working of iron and steel and the making of textiles were the leading industries, as they are in nearly all manufacturing nations. Germany led the world in the manufacture of dyes, chemicals, and beet sugar. Shipbuilding had become a great industry, and in the manufacture of guns of all kinds no country equaled her. In manufacturing, as in all other industries, Germany made full use of scientific men and of scientific methods, and to this

practice much of her success was due. Following the war most industries were at low ebb, but there can be little doubt that a people as industrious as the Germans will again build up their industries and their commerce.

Cities. — Germany is a country of many large cities. There are no less than 40 that have more than one hundred thousand

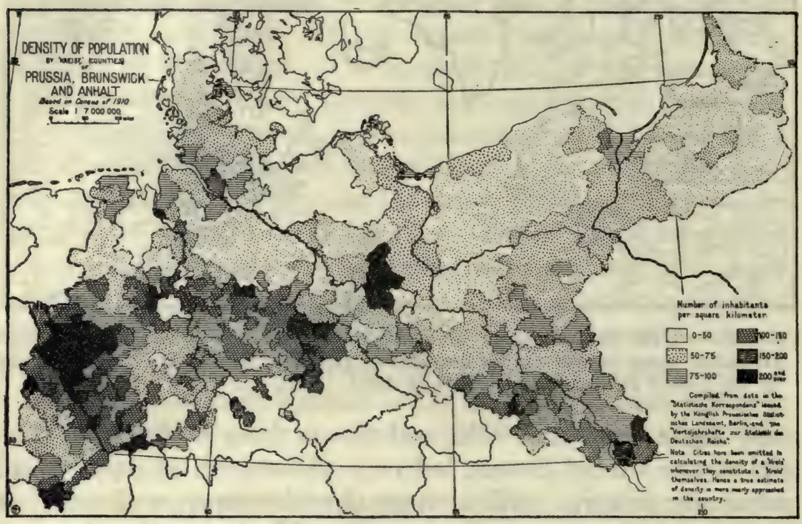


Fig. 362. — Density of population in Germany (1910). In the sandy North-German plain the population is much less dense than in the South where the minerals give rise to manufacturing. (*Van Cleef, Bul. Am. Geog. Soc.*)

population. *Berlin* grew nearly as fast as Chicago and has a population of over two millions; *Hamburg*, the chief port, has a million; and *Leipzig, Breslau, Cologne, Dresden,* and *Munich* have over half a million each. *Essen*, in the Ruhr coal district, was the seat of the great Krupp gun works.

Summary

In almost every field of human endeavor Germany occupied a leading position. With abundant resources of coal, iron, and potash, and considerable resources of other minerals, an invigorating climate, central position, strong government, the best of

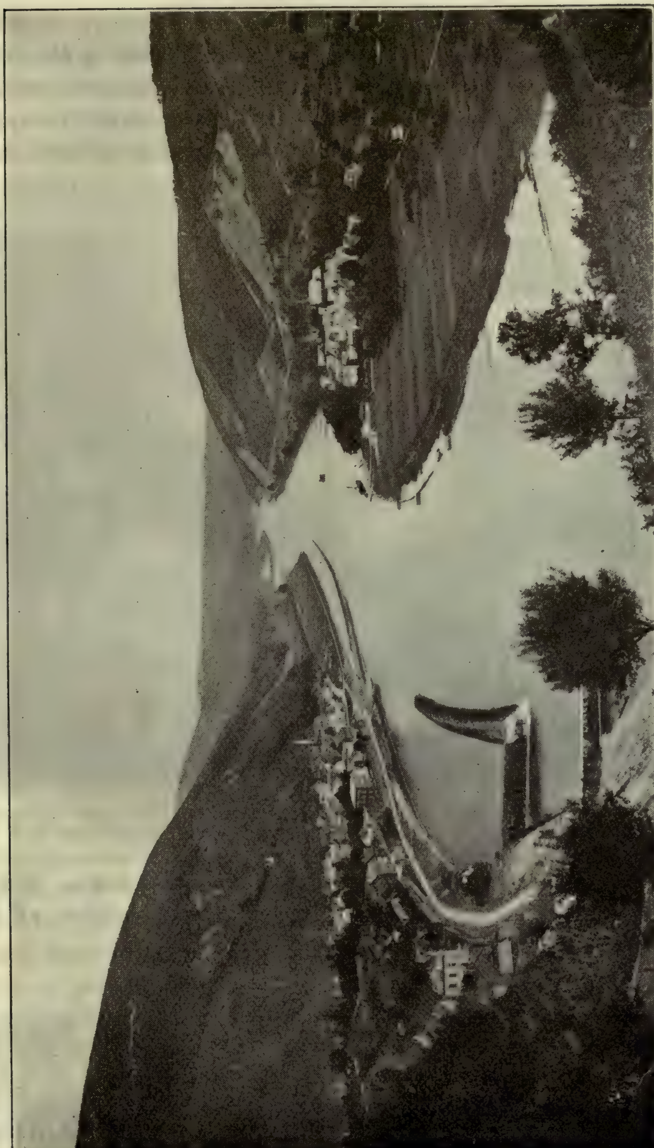


Fig. 363. — Scene in the beautiful valley of the Moselle, flowing from France into Germany.

educational facilities, and a gifted people, Germany might by peaceful methods have become the foremost nation in the world. Her agriculture, mining, manufacturing, and forestry methods were thoroughly scientific. Her rail and inland water transportation was highly perfected. Her manufacturing industries and

FIG. 364. — Scene along the Meuse at Namur, Belgium. This valley formed the route of the invading German army in 1914. (© *Keystone View Co.*)

foreign trade were rapidly rising to first place in Europe. But her territory was too small to satisfy her rulers, who risked all in a disastrous war, and lost.

Belgium and the Netherlands

These two little countries, each about as large as Maryland, occupy strategic but dangerous geographical positions. For commerce they are favorably situated, and before the war each had a larger foreign trade than Russia. Their position is danger-

ous because they lie in a part of Europe where the conflicting interests of great nations meet. We know what happened to Belgium in the recent war, and we can understand what a perilous position a little country occupies when it lies between powerful rivals.

Belgium is one of the most highly developed manufacturing countries in Europe, and the most densely populated, having an average of one person for every acre of land. It is sometimes called the "Workshop of Europe" because of its many factories. Moreover, Belgium is one of the most carefully tilled parts of Europe; 60 per cent of the country is under intensive cultivation. The amount of foodstuffs that the little country produces is almost past belief. Much of the cultivation is done by hand; there are over 500,000 little farms of less than 2½ acres each. The yield of wheat per acre is about three times the average in the United States, and sugar beets and potatoes yield very heavily under the careful cultivation which they receive.

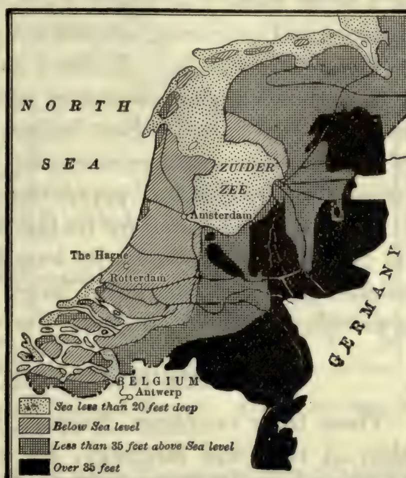


FIG. 365. — Map showing elevations of the land of Holland. (*Tarr and McMurry.*)

Antwerp, one of the foremost ports of the world, is not on the coast, which is low and sandy, but on the Scheldt River, which flows through Holland to the sea. *Brussels*, the capital, is a great industrial center. Under normal conditions Belgium has a foreign trade of nearly $2,000,000,000 a year.

Holland occupies the delta of the Rhine. A quarter of it is below sea level and has to be protected from inundation by means of dikes (Fig. 365). The ceaseless fight against the sea which plucky little Holland has kept up for centuries has called forth the admiration of the world. Projects are now under way to reclaim

a part of the Zuider Zee. Canals and navigable rivers traverse the country in every direction and a tenth of the people live on barges. The *polders* (diked lands below sea level) are kept drained by constant pumping. There are no minerals except clay and a very little coal, hence the country has made less progress in manufacturing than Belgium. A quarter of the land is devoted to crops and a third to pastures. Agriculture and dairying and the raising of a great variety of flower bulbs for export are characteristic industries. Commerce, shipbuilding, and fishing employ a large number of the people. Holland owns the chief islands of the East Indies, the most prosperous and productive tropical colonies in the world. This valuable East Indian trade, however, is only a part of the extensive commerce carried on by Dutch merchants. In proportion to size and population, Holland is a wealthy nation. It is to be remembered for its fine dairy cattle and dairy products, its proverbial cleanliness, its long fight with the sea, its valuable colonies, and its remarkably large commerce. Locate *Rotterdam*, *Amsterdam*, and *The Hague*. For what is The Hague noted?

The Scandinavian Countries

These three countries, Norway, Sweden, and Denmark, closely akin in race and language, are now separate nations, though at times two of them and even all of them have been united.

Norway is a land of nearly barren mountains; less than 4 per cent of the area is cultivated, while 70 per cent is barren. The forests, though they cover a fifth of the area, are for the most part thin and poor, and there are almost no mineral resources. Norway has a most remarkable coast, fringed with thousands of islands and notched by hundreds of fiords. (See page 327.) The coast is mild in temperature on account of the winds from the Atlantic. (See page 306.) Even the port of Hammerfest, beyond the Arctic circle, is ice-free the year around. So far north is Norway that at North Cape daylight is continuous for 73 days in summer, and night is continuous for 73 days in winter. Nowhere in Norway does actual darkness exist during the middle weeks of summer, for the twilight and the dawn extend throughout the short nights.

There is a great amount of water power, as yet only partially used, but little manufacturing is done. The land of Norway offers few opportunities and, as a result, the Norwegians long ago took to the sea and became famous boat builders and mariners.

Fig. 366. — Map showing the glaciated portion of Europe. Arrows indicate the general direction of ice movement.

The Northmen of the Middle Ages were the sea rovers (Vikings) and pirates of their time. The present Norwegians are one of the principal seafaring peoples of Europe. Thousands of them are on the ships of other nations, and the Norwegian merchant fleet, in proportion to the population of the home country, is the largest in the world. The total population of Norway is less than that of Chicago and the capital, Christiania, is a city of 250,000.

Sweden is larger than Norway, has greater resources and more than double the population. The southern third is agricultural land of good quality. Over half of Sweden is forested. The iron deposits are among the most valuable in Europe, though the principal mines are beyond the Arctic circle. The forests are the leading source of wealth, and the production of lumber, timber, pulp, and paper is the largest industry; as an exporter of lumber, tim-

ber, and other forest products Sweden ranks next to the United States; for example, there are 180 pulp mills and 80 paper mills in the country. Manufacturing, especially in the south, has undergone a notable development in recent years. Sweden has great water power possibilities but very little coal. About half of the people are engaged in agriculture, though only nine per cent of the total area is cultivated. Stockholm, the capital, has over 400,000 population.

Denmark is a small, flat, sandy country whose population of less than 3,000,000 has made a remarkable success of dairy farming. Danish butter, eggs, and bacon bring the highest prices in the London market; it is said that Denmark supplies the Londoner's breakfast. Because of the intelligent coöperative methods employed by her people in preparing and marketing their products, Denmark, though very poor in resources, has become a prosperous country. There are no mineral resources, no forest resources, no water power, and not a great deal of manufacturing; but in a normal year little Denmark exports 200,000,000 pounds of butter, 250,000,000 pounds of bacon, and $30,000,000 worth of eggs. Exports amount to $10 for every acre of land in the kingdom, so far as known, the highest record made by any country. Copenhagen, the capital, has a population of nearly half a million.

Russia and Countries Severed from It

The Russia of 1914 was one of the powerful nations of the earth, and its territory included one-sixth of the land of the world. Its population estimated at upwards of 150 millions lived under the tyranny of an autocratic government. Only a limited class received an education; the great mass of the people were simple-minded peasants who gained a living by crude methods of agriculture; the greater part of the land belonged to the royal family, the government, and the nobility. There were few good roads, but there was a fair railroad system with one long line reaching entirely across Siberia to the Pacific; this is the longest railroad in the world. Manufacturing was largely confined to the western part of European Russia.

Minerals. — The oil field at Baku on the shore of the Caspian Sea was once the largest producer of any single field in the world, and gave Russia second place in the production of petroleum. There are large coal resources, the most productive mines being in the Donetz Basin of southern Russia. The gold mines of the Ural Mountains and of Siberia placed Russia among the five leading gold-producing nations. Over 90 per cent of all the platinum mined in the world came from the Ural Mountains. Iron, some of it of the highest grade, is abundant. Most of the other minerals were mined somewhere in the vast empire, but only an imperfect knowledge of the country's mineral resources exists.

Forests. — The north of Russia and parts of Siberia have forests of vast extent. Russia, next to Sweden, was the chief European source of lumber and timber.

Finland, which was conquered by Russia in 1809 and made a Russian province in 1899, separated itself from Russia after the revolution of 1917 and has set up an independent republic with the capital at Helsingfors. The country is larger and more populous than Norway and has more resources. Many of the people are well educated and progressive and all are very patriotic. There are extensive forests, but agriculture is the chief industry.

Poland, which was divided among Russia, Prussia, and Austria many years ago, has become an independent republic with Warsaw as the capital. Other sections of Russia, including **Esthonia, Lithuania, Latvia**, and **Ukrainia**, have set up separate governments, but their success is uncertain. Poland has an area about as large as that of Germany; it includes excellent farm lands, coal fields, salt mines, and manufacturing cities. The Poles are intensely patriotic and include in their number a great many able men. The boundaries of Poland are hard to fix, for the country has no natural boundaries. Poland suffered terribly in the war and it was for years in a pitiable condition. It will have a very hard time maintaining a national existence.

Georgia and **Azerbaijan** in southern Russia and the **Far Eastern Republic** in Siberia detached themselves from Russia and set up independent states.

Switzerland

Scenery. — The greatest resource of this little republic of the Alps is its wondrous scenery (Fig. 367); it includes the finest ranges of these mountains with their 1077 glaciers. The Alps occupy three-fifths of the area of Switzerland, but the greater part of the people live in the lower lands north of the Alps. The peaks, the

Fig. 367. — Among the Swiss Alps in winter. The town of Engelberg. (*Physiography Lab. Cornell Univ.*)

glaciers, the lakes, the deep green valleys, the cascading streams, the mountain passes, the excellent roads, and the good hotels all combine to make Switzerland the playground of Europe and to attract hundreds of thousands of tourists every year. There are said to be 2500 hotels, employing 50,000 servants. Thousands of the Swiss people derive a large part of their incomes from serving the travelers, and providing for their wants, and from the sale of souvenirs or other articles. Visitors left fully $50,000,000 a year in Switzerland prior to the World War.

Other Resources. — Mountainous regions are often rich in minerals, but it is not so in Switzerland. The country has practically no mineral wealth — not even the much needed coal and iron. Twenty-eight per cent of the land is used for pasture or meadow and half as much more can be cultivated, but this supplies scarcely half of the food which the 4,000,000 people need; the rest is imported. The climate is damp, the rainfall heavy, and the land rugged; all this makes the pasturing of goats, sheep, and cattle (especially cattle) more appropriate than agriculture. Many of the chief rivers of Europe have their headwaters in the Alps, and they are capable of yielding enormous water power, but only one-third of it is used. The forested lands supply firewood and lumber, mainly for local use.

Swiss Industries. — There are, in addition to caring for tourists, two dominant industries in Switzerland, (1) the raising of cattle for dairy products and (2) manufacturing. In summer the Swiss herdsmen drive their cows far up the mountain sides, where they feed upon the rich grass, and from their milk and also from the milk of goats the famous Swiss cheeses are made. Much condensed milk and milk chocolate are also made and exported.

Manufacturing. — It would hardly be expected that a country without coal or iron or many raw materials would become a manufacturing country, yet Switzerland is distinctly such. As many people are engaged in manufacturing as in agriculture and herding combined. Skilled labor is abundant and quite cheap; the Swiss manufacturers specialize in products of small bulk and high value, notably cotton, silk, and woolen goods, embroideries, expensive watches, delicate machinery, and scientific instruments. Wonderful wood carving is done. From ten million to twelve million Swiss watches are made yearly.

Transportation. — The position of the country between four important nations makes it a crossroads of traffic. The excellent Swiss railroads, the principal ones owned by the government, form parts of great through lines between the north of Europe and Italy, between Paris and Italy, and between Paris and Vienna. Remarkably fine automobile roads traverse the valleys and zig-

zag up the slopes and over the passes. Under the most important passes railway tunnels have been constructed, the St. Gothard (10 miles long) and the Simplon (12 miles long) being the most famous. Many special cable roads and cog roads have been built to enable tourists to reach points of particular scenic beauty.

The People and Government. — The people of Switzerland, though intensely patriotic, have no national language. The country is divided into 22 cantons; in 15 of these German is spoken; in 5 French, and in 2 Italian. The government is extremely democratic. Education is general and nearly all of the people can read and write; there are seven universities, some of them of high standing. The capital is Bern. Geneva has been selected as the seat of government for the League of Nations.

The Mediterranean Countries

Handicaps. — For a long time the Mediterranean region constituted the greater part of the known world. It was the cradle of European civilization, but declined in relative importance as the known world expanded into northern Europe and across the Atlantic. Three geographical reasons help to explain this decline in contrast with the rise of the North Sea countries:

1. *The Climate.* — In the Mediterranean lands, which in summer lie in the belt of horse latitudes, the rainfall comes chiefly in winter; this is not favorable for agriculture.

2. *The Topography.* — The Mediterranean countries are mountainous with a relatively small proportion of agricultural land; agriculture is, however, the principal occupation of the people.

3. *The Shortage of Minerals.* — The region is almost wholly lacking in coal (Fig. 352), which is now so essential to manufacturing and transportation; moreover, the prolonged drought of summer reduces the flow of streams and restricts the use of water power.

Thus are the people of these lands handicapped in three of the leading occupations in which men engage; namely, agriculture, mining, and manufacturing. Spain is an exception, so far as mining is concerned, for Spain is rich in minerals; yet the key

mineral, coal, is there only in limited amount. It is true that the majority of the people in these lands get their living from the soil, but for most of them it is a poor living; the mountainous land demands a maximum of labor for a minimum return.

Products. — Wheat is the chief cereal grown and both Italy and Spain devote a large part of their agricultural land to it; yet they

Fig. 368. — The chief olive-growing regions of Europe. (*U. S. Dept. of Agr.*)

do not raise enough for their people and must import it. The Mediterranean region is the region of the olive and the grape (Figs. 368, 369). The Po Valley of Italy is the third largest producer of raw silk in the world, and the cork oak trees of southern Spain and Portugal supply most of the world's cork, as Greece supplies a large part of the dried currants. Chestnuts constitute an important item of food in the mountainous region: *e.g.*, Italy produces 600,000 tons of chestnuts a year. Lemons and oranges, particularly in eastern Spain and in Sicily, are noteworthy crops. It will be seen that the Mediterranean lands are forced to the production of many specialized crops rather than the great staple food-

stuffs; these are crops demanding hand labor and cheap labor.

General Conditions. — Northern Italy has a high development of manufacturing, and parts of Spain (especially Barcelona) have

FIG. 369. — The chief grape-raising regions of Europe. (*U. S. Dept. of Agr.*)

developed manufacturing to a considerable degree, yet both are largely dependent upon imported (and expensive) coal and imported raw materials. In these countries wages are low, the working people are poor, sometimes distressingly poor, military service is compulsory, there is little money for public education, and emigration is constant; in fact the money sent back by emigrants is an important item in the support of the people at home.

Italy is included among the great powers of Europe, yet Italy is having, and must continue to have, a hard struggle to meet the financial demands arising from her great war debt. Her resources are small; coal is almost prohibitive in price and taxation is necessarily heavy. In recent decades, millions of Italians have come to America and they form one of the largest elements in our foreign-born population.

Spain has large mineral resources, iron, copper, lead, silver, zinc, quicksilver, and some coal, but the greater part of the mining is

done by foreign corporations, and Spain derives only a part of the benefits. The main part of Spain is a semibarren plateau. Railroad transportation is inadequate; the government is inefficient, and capital is lacking.

FIG. 370. — The Corinth Ship Canal in southern Greece. (*Physiography Lab. Cornell Univ.*)

Though not actually a Mediterranean country Portugal is an integral part of the Iberian Peninsula, differing comparatively little from Spain in its physical features. The republic has small resources and an unstable government but possesses two promising colonies in Africa.

Greece is a country of intense national spirit, but small resources. The area was about equal to that of Pennsylvania, but it has been increased and new territory has been acquired (and some of it lost) as the outcome of recent wars. The country is poor; for example, the total yearly revenue of the government of Greece is

about the same as the cost of maintaining the public schools of New York City. The annual value of all manufacturing in Greece and the total number of persons engaged in manufacturing are less than those of the Ford automobile factory in Detroit. The Greeks have always been a seafaring people and Greek sailors are numer-

FIG. 371. — Map of Czechoslovakia. (*Modified from map by Am. Geog. Soc.*)

ous, especially on the Mediterranean. Many Greeks have come to America and now form an important element in our city population. The world has an unusual interest in Greece because of its illustrious past, when the Greeks were the most intellectual and artistic of all peoples. The debt of modern civilization to ancient Greece is very great indeed. The chief exports of Greece are tobacco and small dried grapes, called currants.

The Mediterranean countries have many famous cities. Locate: *Rome, Genoa, Naples, Florence, Milan, Palermo, Athens, Constantinople, Saloniki, Madrid, Barcelona, Lisbon, Trieste, Fiume.*

SOUTHEASTERN EUROPE

Czechoslovakia. — The World War made great changes in southeastern Europe. The defeat of the Central Powers brought a

complete break-up of Austria-Hungary. The northern part, mainly inhabited by Slavs, became the new republic of Czechoslovakia (chěck-ō-slō-văk'ia) with an area equal to that of New York State and a population of about 14,000,000. It lies between Ger-

FIG. 372. — All that is left of Austria. (*Am. Geog. Soc.*)

many and German Austria and is one of the important mining and manufacturing sections of central Europe. The people are energetic and resourceful, education is general, railroads are numerous, agriculture is efficiently conducted, there is skilled labor, capital, and coal for the industries, and the country is making good progress (Fig. 371).

Austria. — Austria has been reduced to an area equal to that of South Carolina (Fig. 372). The people are German in language and sympathy, but were not allowed by the peace treaty to unite with Germany. The country has been in a desperate condition following the war. It is now only a fragment of what was once a proud and powerful empire. Of all the wrecks

resulting from the World War, none was so complete as that of Austria, the nation regarded as most directly responsible for precipitating the war. Vienna was one of the most beautiful capitals in Europe, but the present Austria cannot maintain a capital of 2,000,000 population, and the great public buildings, parks, and boulevards of Vienna cannot be kept up as they formerly were.

Hungary. — Hungary, the other member of the old Austro-Hungarian monarchy, is a distinctively agricultural country, now about the size of Pennsylvania; it was one of the leading cereal producers of Europe. By the peace terms, it was reduced to about half its former size, the major part of the lost territory going to Rumania. Like Austria it has no seacoast, is heavily burdened with war debts, and has a difficult future. Both countries have attempted a republican form of government, but with uncertain success. The capital of Hungary, *Budapest*, was the leading flour milling center of Europe.

Rumania. — The kingdom of Rumania was nearly doubled in size by territory acquired as a result of the war; it is now nearly as large as Italy, and has a population of about 15,000,000 people, the great majority of whom are engaged in agriculture and stock raising. A major part of the country is composed of fertile plains which produce large quantities of wheat and other grains for export. It is also a part of the south European corn belt. *Bucharest*, the capital, is a modern city. Like other parts of southeastern Europe, Rumania does little manufacturing, but it is one of the more promising countries of this region.

Jugoslavia. — The kingdom of Jugoslavia[1] (yū-gō-slă′vi-a), one of the products of the World War, consists of the former kingdoms of Serbia and Montenegro and of certain provinces that were formerly held by Austria-Hungary. With the exception of the part near the Danube it is a mountainous land whose people are mainly engaged in crude agriculture and stock raising. It is now the largest of the Balkan countries, has mineral and forest resources, and a seacoast on the Adriatic. In most respects it is a backward country needing roads, railroads, schools, and the development of mining and

[1] The official name is the Kingdom of the Serbs, Croats, and Slovenes.

manufacturing. Its capital, *Belgrade*, is a city of about 100,000 population.

Bulgaria — an independent nation since 1908 — joined Austria-Hungary and Germany in the World War, and, as a result of defeat, lost a part of her territory, though not a large part; most of this was annexed to Greece. The country, like the other Balkan countries, is mountainous in character and backward in many of the elements of modern civilization. A minor part of the land is cultivated, very little mining is done, and manufacturing and transportation are in the early stages of development.

The population is much mixed, including Turks, Greeks, Rumanians, Slavs, and Germans, in addition to the Bulgars themselves. The total population is about 5 millions. The agricultural land is held in small parcels by the owners, but most of the grazing land and woodland is owned by the communes (communities), and is used more or less in common. Partly on account of their rugged surface, the Balkan States are one of the principal sheep and goat raising regions of Europe.

Summary of Boundary Changes and New Nations

The chief changes of boundaries which the war brought about are as follows: (See Fig. 348.)

1. France regained Alsace-Lorraine from Germany.
2. Denmark regained from Germany the northern portion of Schleswig.
3. Finland, formerly a part of Russia, was made an independent nation.
4. The Polish parts of Germany, Russia, and Austria were reunited and Poland again became an independent nation.
5. Northern Austria-Hungary became the new nation of Czecho-slovakia.
6. Italy regained the province of Trentino from Austria and also gained additional territory on the Adriatic, including the port of Trieste.

7. Rumania gained territory from Hungary and Russia, nearly doubling its former area.

8. The new state of the Jugoslavs (South Slavs) under the leadership of Serbia, gained Montenegro and the southern part of Austria-Hungary.

9. Austria-Hungary entirely disappeared as a nation, while Austria and Hungary still exist as small independent nations.

10. Turkey practically disappeared from Europe and lost some of her Asiatic territory. Constantinople was left under Turkish rule.

11. Greece gained most of the land that Turkey lost in Europe and a small section of Bulgaria.

12. Former provinces of Russia, Esthonia, the Ukraine, Latvia, and Lithuania, attempted independent existence, but their status is uncertain.

13. Two small states in the Caucasus region, formerly included in Russia, have set up independent governments.

EXERCISE XXIX

1. Why is Europe, strictly speaking, not a continent?
2. Why has it so many peninsular projections?
3. Why does it naturally divide into many separate nations?
4. Why was it more easily possible for Russia to grow large than for other European countries?
5. Why are the river mouths of the British Isles estuaries?
6. Why has the separation of the British Isles from the continent proved beneficial to the former?
7. Why is France ideally situated for foreign commerce? Has France fully improved her opportunities for commerce?
8. Why, in your judgment, did Germany outstrip France commercially?
9. Why is Germany well situated for international trade in Europe?
10. Why is the climate of all northwestern Europe unusually mild for the latitude?
11. Why has Belgium become a manufacturing nation and Holland more largely an agricultural nation?
12. Why are there so many canals and windmills in Holland?
13. Why is the Po Valley very fertile? Why is the climate of Italy mild?
14. Why has Italy such a peculiar shape?
15. Why are so many Norwegians fishermen or sailors?
16. Why are the rivers of Norway and Sweden short?
17. Why is agriculture more important in Sweden than in Norway?

18. Why is Italy milder in climate than our northern states in the same latitude?

19. Why is the geographical position of Belgium regarded as both advantageous and dangerous?

20. Why is a small part only of the iron ore of Sweden smelted in Sweden?

EXERCISE XXX

1. Give reasons for the large foreign trade of the United Kingdom; France; the Netherlands.

2. In what European countries is agriculture the principal industry? Why?

3. Compare and contrast agricultural conditions in the United Kingdom, France, Belgium, and Denmark.

4. In what parts of Europe is wheat a main crop? rye? potatoes? sugar beets? corn? grapes? flax? olives? Give one reason in each instance.

5. What countries have coal in large quantities? What ones find it necessary to import it? What countries export it in considerable quantities? To how great a degree do the native coal supplies of a country determine the extent of its manufacturing? Give examples.

6. What rivers of Europe are important highways of commerce? Locate them.

7. Account for the dry summer climate of the Mediterranean countries. What are some of the chief effects?

8. Arrange the following cities in order of latitude, the most northerly first: Berlin, Madrid, Petrograd, Paris, Rome, London, Constantinople, Chicago.

9. Select the five European countries which you consider to have the most advantageous position for foreign trade. In what order would you rank them in this particular?

10. What European countries would suffer most if all trade with other countries were cut off? What ones would suffer least? Give a reason in each case.

11. What ten cities would you name as important ports of Europe? Locate these cities.

12. Most European countries have gained a reputation for the manufacture of some particular article or articles. Name some of these articles in the case of the more important countries.

13. What parts of Europe have an exceptionally dense population? Suggest the reasons.

14. Contrast Holland and Belgium in their industrial activities; Norway and Sweden; France and Spain.

15. What European countries would suffer seriously if they were quickly cut off from all trade with the United States? Explain how and why.

16. Are we chiefly dependent upon Europe for markets for our products or for imports which we actually need? Explain.

17. What countries of Europe would you name as being richly endowed by nature, and what ones as being handicapped by nature, but effectively developed by man's efforts? In what ones has man conspicuously failed to do his part? In what ones have man and nature coöperated most effectively?

CHAPTER XXIV

JAPAN AND CHINA

Japan

The Expansion of the Empire. — Up to 1854 the Japanese were almost an unknown people. Like the Chinese they were suspicious of foreigners and wished to keep them out of their country. The opening of Japan was mainly due to the efforts of the American Government, represented by Commodore Perry, who visited Japan in 1853 and 1854 with two warships and induced the Japanese Government to open their country to foreign trade. Since 1889, Japan has been a constitutional monarchy, ruled by a parliament and a Mikado whose ancestors are said to have ruled Japan continuously since 660 B.C.

The rapidity with which Japan has gone forward has had no parallel in history, and to-day the nation is recognized as one of the world powers. By defeating China in 1895 and Russia in 1905, Japan became the dominant power in the Far East. In 1910 Korea (now called Chosen) was formally annexed, and Japan's influence in the Chinese province of Manchuria has become so strong that this province may eventually be absorbed into the Japanese Empire (Fig. 373). The navy and merchant marine of Japan have grown very rapidly; Japanese steamship lines are reaching out to many parts of the commercial world. Her manufactures and commerce have also grown with remarkable rapidity.

Geographical Conditions. — The original empire consisted of three large islands and many small ones, to which have been added the dependencies of (1) Chosen, (2) the large island of Formosa, taken from China, (3) the island of Sakhalin, taken from Russia, (4) Port Arthur on the coast of China, and (5) certain groups of


CHINA
AND JAPAN
Scale of miles
0 100 200 300 400 500 600
ELEVATIONS IN FEET
above 15,000
5000 to 15,000
1000 to 5000
0 to 1000
Longitude East from Greenwich
Williams Engraving Co., N.Y.
70° 80° 90° 100° 110° 120° 130° 140° 150°
50 40 30 20
SIBERIA
CHINESE REPUBLIC
MONGOLIA
MANCHURIA
TIBET
CHINA
CHINESE TURKESTAN
PLATEAU OF TIBET
Desert of Gobi
INDIA
NEPAL
BHUTAN
FRENCH INDO-CHINA
SIAM
CHOSEN (KOREA)
JAPAN
HOKUSHU
HONSHU
SHIKOKU
KYUSHU
SAKHALIN I.
TAIWAN (FORMOSA)
HAINAN
PACIFIC OCEAN
SEA OF OKHOTSK
SEA OF KAMCHATKA
JAPAN SEA
Yellow Sea
EAST CHINA SEA
BAY OF BENGAL
G. of Pechili
G. of Tonkin
Gulf of Tartary
Tsugaru Strait
Korea Strait
Formosa Str.
KURIL ISLANDS
NANSEI ISLANDS
Lake Balkash
Lake Baikal
Lob Nor
Tungting L.
Poyang L.
Irtish
Ob R.
Yenisei R.
Tarim R.
Hwang
Yangtze
Grand Canal
Liao R.
Sungari
Amur R.
Shilka R.
Argun R.
Ganges R.
Brahmaputra R.
Salwin
Altai Mts.
Sayan Mts.
Thian Shan
Kuen lun Mts.
Nan Shan
Himalaya Mts.
Great Khingan Mts.
Mt. Everest
Fujiyama
Tropic of Cancer
Mouths of the Ganges
GREAT WALL OF CHINA
Below sea level
Irkutsk
Kiakhta
Chita
Chailar
Aigun
Tsitsihar
Harbin
Kirin
Khabarovsk
Vladivostok
Mukden
Newchwang
Kobdo
Uliasutai
Urga
Kulja
Tihwafu (Urumtsi)
Turfan
Barkul
Hami
Aksu
Kashgar
Yarkand
Soochow
Kalgan
Peking
Tientsin
Chengting
Taiyuanfu
Tsinan
Dairen
Port Arthur
Chefoo
Weihaiwei
SHANTUNG PEN.
Tsingtao
KIAOCHOW
Keijo (Seoul)
Fusan
Lanchow
Sianfu
Kaifeng
Nanking
Chinkiang
Rudok
Lassa
Darjiling
Batang
Chengtu
Ichang
Hanyang
Hankow
Wuchang
Wuhu
Soochow
Shanghai
Hangchow
Ningpo
Wenchow
Kiukiang
Nanchang
Chungking
Changsha
Kuiyang
Tali
Yunnanfu
Munipur
Bhamo
Calcutta
Mandalay
Foochow
Amoy
Changchow
Swatow
Tamsui
Tainan
Canton
Wuchow
Fachan
HONGKONG
Victoria
Macao
Kwangchow
Hanoi
Sapporo
Otaru
Hakodate
Sendai
Niigata
Toyama
Kanazawa
Nagoya
Tokyo
Yokohama
Kyoto
Kobe
Osaka
Hiroshima
Fukuoka
Nagasaki
Kagoshima

FIG. 373

islands in the Pacific, taken from Germany at the end of the World War of 1914–18.

The main islands of Japan lie in the north temperate zone, partly in the belt of prevailing westerlies and partly in the region of the

FIG. 374. — Preparing a rice field for planting, in Japan. (*Phila. Museums.*)

monsoon winds. The climate is invigorating and the people are an alert and energetic race. Rainfall is abundant; snow falls on all of the main islands, although Tokio, the capital, has only three or four snowstorms in an average winter. All of the islands are mountainous and there are some fifty active volcanoes. In fact, the Japanese chain of islands is essentially a mountain system which is still growing. Earthquakes are of daily occurrence somewhere in the islands. The short rivers, plunging down the mountain valleys, are torrential. The coast line is irregular and good harbors are fairly numerous.

Agriculture. — Until a generation ago, nearly all the people of Japan lived by agriculture supplemented by fishing; and agriculture is still the most important occupation (Fig. 374). The country is so mountainous that only about 15 per cent of the

land can be cultivated, but this is cultivated with an intensiveness scarcely equaled anywhere else in the world. Two or three crops a year are taken from the same land, and the population of over 60,000,000 is fed very largely from home-grown food, although only one-third as much land is under cultivation as in Illinois. Rice is the national food and about 50 per cent of the cultivated land is devoted to this crop (Fig. 374). Japan, small as it is, raises more rice than Canada does wheat. As a rule the rice fields are tiny, averaging only one-eighth of an acre in size. A million acres raise mulberry trees for feeding silkworms. Tens of thousands of families raise silkworms as a domestic industry; raw silk is the largest export of Japan, and most of it comes to the United States.[1] Farms are very small, averaging two and one-half acres; over half of them are tilled by their owners. Barley and wheat are, after rice, the leading grains (Figs. 375, 376). Tea is not particularly important in Japan. Good land commands a high price, because so little of the total area can be cultivated. The country raises very little live stock of any kind, partly because land is more valuable for the production of crops.

FIG. 375. — (*U. S. Dept. of Agr.*)

Minerals. — Japan is fortunate in having coal enough for present needs. The annual output of 30 million tons is about one-twentieth of that of the United States. Her copper mines supply all domestic needs and yield a surplus for export. The country produces considerable petroleum, a small amount of gold, and a larger amount of silver, and some other minerals (Fig. 378). The most serious shortage is in iron. Japan aspires to become a manufactur-

[1] Members of the class should prepare special reports on the silk industry and on rice cultivation.

ing nation and will need more iron than her own deposits can supply. China has large deposits of iron ore, and naturally Japan looks there for her needed supplies; this is one reason why Japan would like to have as much influence as possible in China. Considering her small area, Japan may be considered as well supplied with minerals excepting iron.

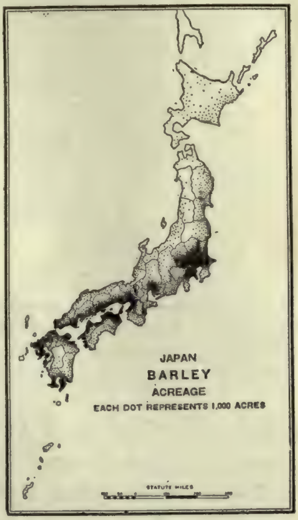


FIG. 376. — (*U. S. Dept. of Agr.*)

Manufactures. — Japanese labor is relatively cheap and abundant; some of the workers are very highly skilled in the peculiar Japanese hand trades. In recent years the Japanese have been making remarkable progress in many lines of manufacturing, including shipbuilding, silk and cotton manufactures, iron and steel products, pottery, and hundreds of small articles, such as fans, toys, cigarettes, matches, etc. It is evident that if Japan is to hold a place among the leading nations she must be a manufacturing nation. So small is her food-producing area and so rapid is her increase of population, that Japan, like England, Belgium, and Switzerland, must to an ever increasing extent purchase imported food and raw materials and pay for them with manufactured goods. Although a large amount of machinery is in use, handwork is still very important (Fig. 379). However, the Japanese are quick to learn new ways, and factories are sure to become more and more numerous.

Foreign Trade. — The commerce of Japan has had a remarkable growth since 1914, increasing about 300 per cent in the four years 1914–18, but declining afterwards. Much of this increase, but not all, was due to advancing prices caused by the war. The leading articles exported are raw and manufactured silk and cotton manufactures, both of which exceed $300,000,000 a year. Seventy per cent of the raw silk produced in Japan is exported, and

seven-eighths of this comes to the United States. The raw cotton is imported mainly from the United States and British India. The cotton goods are sent chiefly to China, India, and other Asiatic

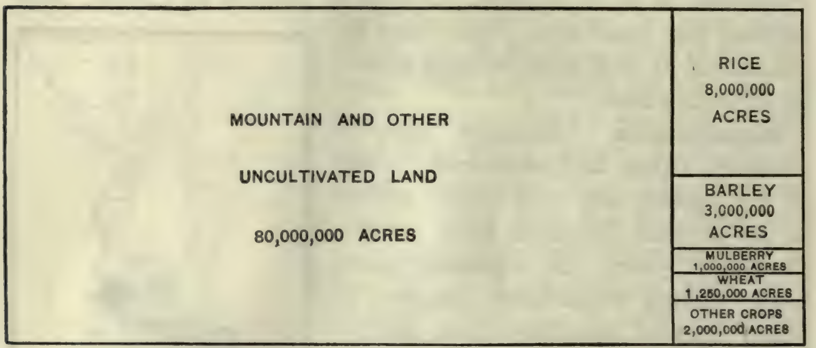


Fig. 377. — The spaces in the above diagram show the proportional areas in Japan devoted to various crops and the area left uncultivated because it cannot be used for crops.

countries. The total foreign trade is beyond 2 billion dollars a year, which is about that of Holland.

Relations of Japan and the United States. — Since the United States acquired the Hawaiian Islands and assumed the control of

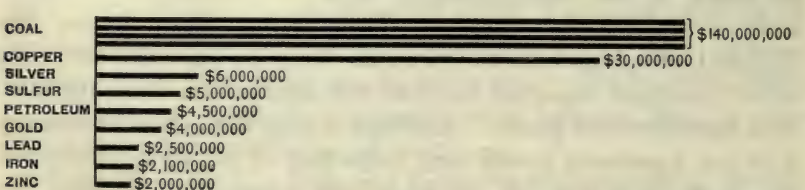


Fig. 378. — Average annual value of the principal mineral products of Japan. Coal has a greater value than all of the other minerals combined.

the Philippines, and since the aspirations of Japan to expand have become clearly evident, there have been, both in Japan and in the United States, certain people who have stirred up suspicion and distrust. The two governments, however, have maintained cordial relations and the great majority of thinking people in both countries desire to continue them. A third of Japan's foreign trade is

with the United States and the cessation of that trade would be a blow to Japan. Every effort to preserve friendship should be made by both peoples. If trouble should arise between the two nations,

FIG. 379. — Reeling silk from cocoons. Silk-production is a leading industry of Japan, and Japan is the foremost producer of raw silk. (*Physiography Lab. Cornell Univ.*)

it is likely to be over China, whose people fear the encroachments of Japan and look upon the United States as their friend.

EXERCISE XXXI

The Study of Japan: A Geographical Problem

GIVEN: An able, aggressive, ambitious people in a restricted area, but intent upon holding a place as a world power.

PROBLEM: What elements in the geography of Japan favor or hinder her ambitions, and why is the United States concerned about them?

QUESTIONS FOR CONSIDERATION:

1. What is the density of population in Japan? (60,000,000 people; 148,000 square miles.)

2. Compare this with the density in the United Kingdom (378 per square mile), Germany (315 per square mile), and France (192 per square mile).

3. What proportion of the area of Japan can be devoted to food production?

4. Can so large a population be supported on such a small area? Can food production in the islands be increased much further?

5. Consider the growth of population in Japan in recent decades (1890, 40,000,000; 1900, 45,000,000; 1910, 50,000,000; 1920, 60,000,000). Suggest ways in which Japan might relieve this pressure of population and food shortage.

6. How did the British Isles meet a similar problem? Belgium?

7. Consider the territorial expansion of the British Empire; of the United States. Are Japan's ambitions to expand justifiable?

8. To what extent is Japan self-sufficient in: (*a*) coal, (*b*) iron, (*c*) petroleum, (*d*) copper, (*e*) cotton, (*f*) other raw materials?

9. Compare Japan with the British Isles in these respects.

10. Could China supply any of the minerals and raw materials needed by Japan? Could Manchuria?

11. As a whole, is the Orient a producer or a buyer of manufactures?

12. What is the population of China? of India? Consider these countries as markets for Japan's manufactures.

13. Might it not be to the advantage of these countries to sell to Japan the needed food, fuel, and raw materials, and purchase manufactures in return?

14. Why should Japan care to gain a large measure of influence in Chinese affairs? In Manchuria?

15. To what extent have other great nations sought similar control beyond their own boundaries? (Consider England especially.)

16. Why are the American people concerned about Japanese ambitions?

THE REPUBLIC OF CHINA

History. — China has a history running back over 4000 years, and many of the laws and customs still in use were established as early as 1000 B.C. Confucius, the most celebrated scholar and lawgiver of China, lived about 300 B.C. The mariner's compass, block printing, and gunpowder were invented in China centuries before they were known in Europe. The Great Wall of North China, 1250 miles long, was completed 2100 years ago. It is said that the Chinese people went to sleep about 200 B.C. and did not awaken for twenty centuries.

In 1912 the Chinese revolted against the Manchu rulers, who had dominated them for nearly 400 years; they deposed the Emperor and adopted a republican form of government. The effort to

maintain a republic has not been very successful, and frequent armed conflicts have occurred between factions, especially conflicts between the North and the South. In spite of its size and great population, China is still a weak nation and greatly in need of

Fig. 380. — Density of population in Europe and Asia. About one-half of the people of the world live in southern and eastern Asia. (*U. S. Dept. of Agr.*)

friendly aid from outside (Fig. 380). The United States has been a sincere friend to China and desires that the nation shall be aided and protected in the long, hard struggle that is before her.

The Five Parts of China. — The Chinese Republic is made up of the eighteen provinces of China proper and four outlying dependencies, which are loosely held; these are Manchuria, Mongolia, Chinese Turkestan (Sinkiang), and Tibet (Fig. 381). Of the four, Manchuria is the most valuable, but the Japanese are getting such a foothold in that region that there is doubt of China's ability to keep it. Mongolia is a desert plateau sparsely occupied by nomadic tribes. In 1922 it was reported that Mongolia wished to secede from China and join Russia. The outcome remains to be seen. Turkestan is for the most part a desert. Tibet is the most lofty plateau in the world; surrounded by mountains, it is difficult to enter, and is but little known to outsiders. British in-

fluence spreading northward from India is becoming stronger in Tibet and Chinese influence weaker. Excepting Manchuria, none of these dependencies is of much value to China, but they act as buffers between China proper and her powerful

FIG. 381. — Comparative areas. (*Map by Froelich in "Asia."*)

neighbors. More than 90 per cent of the people of China live in the eighteen provinces of China proper, which form the southeastern third of the country. In the outlying provinces there is a sparse population and no large cities, but China itself is densely populated and has many cities, including *Peking, Shanghai, Hankow,* and *Canton.*

The Long Isolation. — China had almost no contact with the outside world until the nineteenth century. Between China and the more enlightened people of Asia Minor and Europe there was practically no exchange of ideas. Long ago China pushed her boundaries outward until they reached the great barriers of the desert on the north and west, the almost impassable mountains on the south,

and the sea on the east; but nowhere did she come into contact with peoples from whom she could learn very much, and gradually the Chinese became self-satisfied; they concluded that they were the most enlightened people of the earth, fell into the practice of worshiping their ancestors, and adopted the idea that these ancestors were wiser than their descendants, and that the very best they themselves could do was to imitate them. Because the country was completely isolated from western nations where civilization was going forward, China did not know of her backwardness until she was aroused by the coming of Europeans in the nineteenth century.

The one most significant fact in the geography of China is this geographical separateness in which she lived, a separateness which grew out of her remote location and the almost impassable barriers that separated her from western nations. Only with the development of modern means of navigation was this isolation broken down; and in the interior of China it is still very little changed, where changed at all.

Other Geographical Conditions.—Besides the geographical barriers that shut China off from the rest of the world, several other features of her geography should be noted.

1. The country is very large, a third larger than the United States; it has a great diversity of surface, including vast, fertile plains; range on range of mountains; far-reaching deserts; and a wide diversity of climate from cold temperate to tropical.

2. The two main rivers, the Hwang and Yangtze, have built up flood plains of great extent and great fertility which are now very densely populated (Fig. 380).

3. The principal part of China is in the belt of monsoon winds which bring heavy summer rainfall and aid in making China one of the most productive parts of the world.

Because both soil and rainfall are ideally suited to agriculture the Chinese became a nation of farmers, and because of the great population the farms necessarily are small. So industrious are the people and so intensively do they cultivate and fertilize their land that it produces a prodigious amount of food, practically enough for their population of 400,000,000, or nearly a quarter of the people

of the earth. One serious drawback to life on the flood plains is the occurrence of disastrous floods which sometimes cause the death of as many as a million people by drowning and by famine. The Yangtze River, described in Chapter IX, is the great interior waterway of China. The Hwang has so many rapids and is so turbulent that it cannot be used for navigation, but it brings down and spreads over its flood plain a great amount of fertile, yellow loess, which constantly restores the fertility of the soil. (See page 66.)

Fig. 382. — Map showing about one-third of the canals in 718 square miles of eastern China. (*F. H. King.*)

The Lack of Modern Means of Transportation. — The Chinese have built practically no good roads anywhere in China. In few sections can any wheeled vehicle except a wheelbarrow be used, but there are several thousand miles of canals and navigable rivers upon which an enormous traffic is carried (Fig. 382). A large part of the overland transportation is done by pack animals or by porters who carry goods on their backs or on wheelbarrows. Though labor is cheap, transportation by these methods is slow and expensive if the distance is considerable. This is another cause for the backwardness of China, for no nation can make much progress unless it has good means of transport.

The Great Resources of China. — The mineral wealth of China

is very great; coal occurs in nearly every province. Next to the United States, China has the greatest coal resources of any country, yet only a small amount is mined. These coal deposits, however, will be developed and with the almost unlimited supply of labor which China has she ought some time to become a great manufacturing nation. Iron also exists in large but undetermined quantities, and tin is exported to the value of $5,000,000 a year. Geological explorations in China, though very incomplete, warrant the belief that in mineral wealth the country is one of the richest in the world.

Forests. — Nearly all the forests except those in the most inaccessible mountains have been cut away, resulting in serious erosion of the soil and in a present shortage of timber.

Labor. — One of China's greatest resources is her millions of industrious workers. As yet much of their labor is ineffectually employed because of antiquated methods, but it seems sure that this abundant labor will lead to the upbuilding of the nation's industries, and that some day China will produce not only her own manufactured goods but also a surplus for export.

Agriculture. — Agriculture is the one great industry of China, but the soil can do little more than feed the enormous population. Above all rice is the important crop; the production exceeds 50 billion pounds a year. Nearly all the grains and great quantities of vegetables are raised. There is practically no animal industry except the raising of pigs and poultry. The production of the mulberry and the care of silkworms is widespread and important, as raw silk constitutes the largest export from China. Tea is declining as an export, due in part to the better methods of production employed in India and Ceylon. Cotton is widely grown and is used mainly within the country, although some is exported; China ranks fourth in the production of this staple (U. S., India, Egypt, China). Most of the land is owned by the farmers themselves; it is worked by hand, and by an infinite amount of labor it is forced to produce a surprising amount.

Commerce. — Although the foreign trade is over a billion dollars a year, it is still small in proportion to the population. The people

are too poor to buy very many imported goods, and what they produce is mostly needed at home. China has a per capita trade of less than $3 a year, while that of Australia, New Zealand, and Argentina is more than $100 per capita. The trade is most

FIG. 383. — One method of sawing lumber in Manchuria. (© *Keystone View Co.*)

largely with Japan, the United States, and the British Empire. The trade of China will become very large in time, and all the commercial nations are seeking to gain trade advantages there.

The Present Republic. — In 1912 China became a republic, but great difficulties confront the nation; the people of the North and South are more or less hostile to each other and civil strife breaks out frequently. Money for developing mines, improving transportation, and building up industries is needed in great amounts. Modern education, a get-together spirit, honest government, and friendly aid from outside are essential. In the interior foreigners are still regarded with suspicion. The most serious difficulty is the lack of unity among the various parts of the country, and the impossibility of getting honest public officials who can command the confidence and support of the country as a whole.

Summary

China has the largest population of any country in the world (400,000,000); it is also one of the oldest countries in the world. Surrounded by vast deserts, lofty mountain ranges, and the sea, China remained for thousands of years cut off from contact with western nations. In 1912 the country became a republic in name, but the new government has had a troublous course and its success is still uncertain. The vast majority of the people live on little pieces of land which they till with infinite care and labor, producing a great amount of food. The Chinese are a remarkably industrious people, but they are wedded to their ancient ways and do not readily change them. In the production of rice, silk, and tea, China takes a high but not a leading place. The country is very rich in coal, iron, and most other minerals, but only a small amount of mining is done. Labor is cheap and abundant; roads are few and poor. There are less than 7000 miles of railroad in the whole country. The foreign trade is only $3 per capita. China, though large and populous, is a weak nation and will require the friendship of stronger powers if it is to hold together.

EXERCISE XXXII

The Study of China: A Geographical Problem

GIVEN: A nation with a large area, favorable climate, rich, undeveloped mineral resources, and an enormous population of able people, but as yet not competent to protect itself or achieve its own internal development.

Problem: What elements in the history and geography of China have brought about this helplessness and what is essential to the preservation and upbuilding of the nation?

Questions for Consideration:

1. Area? population? density of population?
2. Of what parts is the Chinese Republic made up? Which ones of these are dependencies (Fig. 381)?
3. Only one of these dependencies is very valuable in itself. Which one?
4. Why are the other three of small value in themselves?
5. In what ways are they of value to China? In what ways would the loss of these dependencies affect China?
6. What country has been gaining an increasing degree of control in Tibet? in Mongolia? in Manchuria?
7. Which of these encroachments is most dangerous to China? Why?
8. Show how China's geographical position and surroundings favored her long isolation? When was this isolation broken?
9. When and how did China become a republic?
10. Comment on the success of the Chinese Republic. What conditions in China seriously handicap the present republic?
11. To what extent is China supplied with (*a*) coal, (*b*) iron, (*c*) petroleum, (*d*) other minerals? Is the country self-sufficient in food?
12. To what extent is the country retarded by lack of transportation facilities? lack of education? lack of capital? lack of national spirit?
13. Discuss the importance of agriculture in China.
14. Consider China as a future manufacturing nation. In what particulars is it (*a*) strong and (*b*) weak?
15. In what important ways is China's future connected with Japan's attitude?
16. To what extent is the United States justified in interesting itself in Far Eastern affairs?
17. Why is the future of China endangered?
18. What does China most need in order to work out its future as an independent, modernized nation?

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